

The JOURNAL OF THE DEPARTMENT OF AGRICULTURE

WESTERN AUSTRALIA

VOL. 8 (Third Series)

NOVEMBER—DECEMBER, 1959

No. 6

Published every second month by the Department of Agriculture, St. George's Terrace, Perth

The subscription rate (which includes postage) is 10s. per annum. Single copies 2s. each.

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Articles which appear in the "Journal" may be reprinted, provided that the "Journal" and the authors are acknowledged.

Issued by direction of
THE MINISTER FOR
AGRICULTURE.

COVER PICTURE

Large-scale wheat harvesting operations on the "Erregulla Springs" property of Mr. E. F. Smart, Mingnew.

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Copper and Cobalt Deficiency of Livestock in Western Australia

[Revised from Bulletin 2227, January-February, 1955]

By H. W. BENNETTS, D.V.Sc., Principal, Animal Health and Nutrition
Laboratories.

PART 1.—DISTRIBUTION AND EFFECTS

DISEASES of animals due to copper and cobalt deficiencies are well known in this State where much of the original work, on the cause of these conditions, was carried out. These investigations have been recorded elsewhere and described briefly in this Journal by Filmer and Underwood (1936), Bennetts (1935), (1937), (1940), (1941), (1942) and Bennetts et. al. (1939), (1942). During more recent years the distribution of these deficiencies in Western Australia has been surveyed in some detail. This survey has been made by field investigations and by chemical estimations of animal tissues and pastures from many localities throughout the State.

With present knowledge it is now practicable to make standard recommendations for the control of these diseases and to indicate more clearly the regions and types of country where they may be expected to occur.

Animals may suffer from a deficiency of either copper or cobalt, or from a dual deficiency, as in "coast disease." Sheep and cattle are the stock mainly affected. Cobalt deficiency affects the ruminant animal only, but copper deficiency may affect horses and pigs as well as sheep and cattle.

In brief, the main sign of cobalt deficiency is a progressive wasting and weakness suggestive of starvation. The signs of copper deficiency vary with the species of animal affected and with the degree of the deficiency. In cattle the growth of young animals is retarded and they appear unthrifty; there may be fading of hair colour, intermittent scouring and lowered production and fertility. If the deficiency is very severe, cows, particularly those in production, may die suddenly from heart failure ("falling disease"). In sheep the occurrence of "stringy" or "steely" wool is the main characteristic in the adult, and lambs may develop a condition known as

ataxia, under conditions of more severe deficiency. Young pigs also may show ataxia. Adult horses appear to thrive on copper deficient pastures, but foals bred on the same deficient areas show abnormalities in the structure and posture of the legs.

Sheep or cattle affected with "coast disease" may die from the effects of cobalt deficiency before they develop definite signs of copper deficiency.

A.—COPPER DEFICIENCY

The animal body requires small amounts of copper for various functions and if adequate amounts are not available the signs of illness, briefly outlined above, may develop. The deficiency may result from an unduly low copper content in the feed available to the animal or, sometimes, from the operation of factors which prevent the animal body from utilizing the adequate, or even high, amounts of copper contained in the diet. The nature and mode of action of these factors causing a "conditioned" copper deficiency are being studied both here and elsewhere.

Fortunately in this State copper deficiency diseases seem to occur, almost exclusively, on pastures which are low in

SKETCH MAP SOUTH WESTERN PORTION OF WESTERN AUSTRALIA

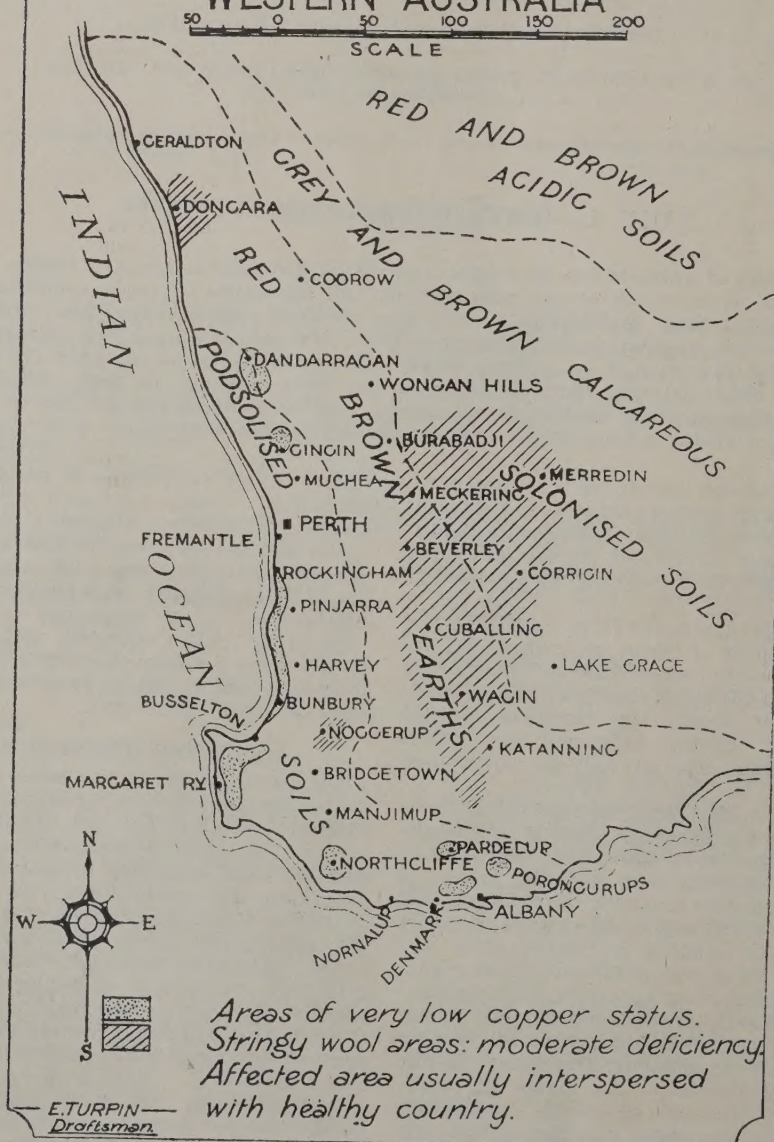


Fig. 1.—Map showing main copper-deficient areas in the South-West of Western Australia

copper content. Their detection and control are, in consequence, relatively simple. The results of surveys reported by Beck (1941), (1951) indicate that where the copper content of pasture is above 6 parts per million stock remain healthy, that with lower values between 3 to 6 p.p.m. signs of copper deficiency may be anticipated, and that with values below 3 p.p.m. severe manifestations (ataxia and "falling disease") are present. The copper content of pastures on which "falling disease" was common was extremely low, usually below 2 p.p.m.

Regions and Types of Country Where Copper Deficiency Occurs in Animals.

The evidence available indicates that much of the western and southern coastal country is deficient. Evidence of deficiency has been observed from Broome in the north to as far east as Hopetoun, on the southern coast. Knowledge of the copper status of animals and herbage in the northern interior, however, is limited. On the other hand the distribution of the main affected regions in the South-Western Division of the State has been mapped (see map).

The regions where a more or less severe deficiency is almost universally present are:—

- (a) Coastal and semi-coastal country. This includes the calcareous wind-blown sands of the coastal fringe, which are invariably deficient in copper (and in cobalt) and the "light" country of the coastal plain which is deficient to a variable degree. The latter includes the banksia and tuart sands, the peaty swamps and much of the country adjacent to Albany.
- (b) The Gingin and Dandarragan districts (cretaceous country).
- (c) The Busselton-Margaret River and Northcliffe districts where a widespread and very severe deficiency exists, particularly throughout the jarrah-redgum belt. Similar country west of Mt. Barker is also markedly deficient. In other types of forest country in the lower South-West, notably in the Denmark, Walpole, Manjimup and Pemberton districts, the deficiency is less severe and more patchy in distribution.



Fig. 2.—A heifer suffering from cobalt deficiency

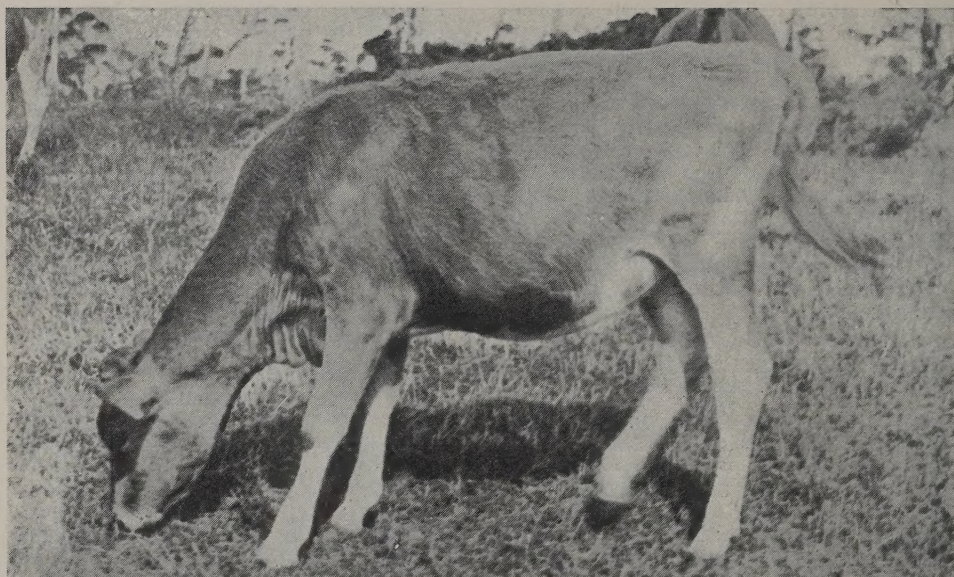


Fig. 3.—The same heifer showing the improvement in condition following upon cobalt supplementation

In the agricultural areas further inland especially in the Great Southern district and the wheatbelt the occurrences of copper deficiency in animals is still more widely scattered, less severe, and more subject to seasonal variations. In these areas, which have been mapped in conjunction with surveys of woolclips initiated in 1941, the manifestations are restricted to seasonal occurrences of "stringy" wool and occasional cases of ataxia in lambs. In some localities only occasional properties are affected, in others, as in the vicinity of Corrigin, the deficiency is more widespread.

Investigations in the region, referred to, have indicated that the types of country likely to be affected are light sandy (or sandy-gravelly) soils carrying predominantly whitegum, tamar and wodgil; or whitegum, associated with stunted jam and sheoak, although these vegetation associations do not necessarily indicate copper deficiency. It appears quite evident, however, that heavier forest country carrying salmon gum or york gum is generally healthy and that where sheep have adequate access to this, as well as to the lighter

types, they are able to obtain sufficient supplies of copper for all bodily needs.

The whitegum, redgum, flooded gum, country of the "clover belt," notably to the west of the Great Southern railway is, almost generally, free from evidence of copper deficiency signs in animals, although some light sandy soil types in this region have been shown to be copper deficient. Here, as elsewhere in the agricultural areas, there may be evidences of copper deficiency if sheep are maintained on areas which are dominantly of the "light" sandy copper-deficient type (e.g. casuarina sands).

The results of a limited number of analyses suggest that the pastures of the ironstone soils (laterites) of the Darling Range are rather low in copper. Controlled experiments with animals have not yet been carried out in this region.

Seasonal Variation.

In the more severely deficient regions animals show evidence of copper deficiency every year, although even here the signs are more apparent during the green feed period than the dry, and in seasons favouring the growth of lush green feed than in drier years.

In the marginally deficient areas signs of deficiency may be slight or absent in some years and definite in others depending on the seasonal influences referred to.

Symptoms of Copper Deficiency in Cattle.

1. Non-fatal Copper Deficiency.

Calves may show signs of deficiency at an early age. Growth is retarded and there is marked unthriftiness. The limbs show abnormalities—pasterns are straight and calves tend to stand up on the toes. Joints, particularly those of the hind legs, are “knobby” as a result of bony prominences. These clear up as the animal reaches the age of 1½-2 years. Diarrhoea and signs of anaemia are commonly noted. With increasing age the animals grow slowly and have a very stunted, undeveloped and unthrifty appearance. On some holdings they cannot be reared into profitable animals and are destroyed. Maximum size is not attained in adults on the worst-affected properties and each successive generation tends to be smaller in frame.

In adult cattle, manifestations are particularly marked during the period from August to October when, despite abundance of green feed, there is some loss of condition and the coat is very rough and “starey.” A severe anaemia, due to copper deficiency, is commonly present during this period; recovery from this is rapid and spontaneous during the summer months.

Depraved appetite is common; cattle eat soil around the roots and butts of upturned trees. Scouring is frequently present. Temporary infertility with suppression of heat is an associated condition; many cows served during the autumn and winter months, although failing to get in calf, do not return to the bull generally until November or December when they are readily stocked. It should be borne in mind however, that temporary infertility may be due to a number of causes other than mineral deficiency. At the same time there is no doubt that the use of copper supplements did facilitate the stocking of dairy and beef cattle in the regions where copper was very deficient.

2. Fatal Cases of Copper Deficiency—“Falling Disease.”

“Falling disease” has long since become a matter of historical rather than of prac-

tical interest. In 1938 we proved that sudden deaths in adult cattle, which had been a source of serious losses in dairy herds in the south-western corner of this State, were actually a terminal manifestation of severe and prolonged copper deficiency. In cattle, but not in other species, this leads to a progressive destruction of heart muscle (atrophy and fibrosis) which commonly results in sudden death from heart failure, as described by Bennetts, Harley and Evans (1942).

Subsequently the universal use of copper fertilisers, in the regions formerly affected, has resulted in a complete control of the problem of “falling disease.”

Symptoms of Copper Deficiency in Sheep.

In the adult sheep the main sign of copper deficiency is “stringy wool.” Anaemia and scouring may also occur under some conditions.

“Stringy wool” occurs even when pastures are deficient to such a mild degree that all other signs are indefinite or absent. In fact the absence of this wool defect in a clip, predominantly of the Merino type, can be taken as reliable evidence that stock are receiving adequate copper from the pastures provided, of course, that copper is not being supplied through blue-stone worm drenches, etc.

The characteristics of “stringy wool,” sometimes referred to also as “slippery” or “straight steely” wool, are loss of crimp and straight, glassy or silky appearance; the fleece lacks “bulkiness.” The defect is much more noticeable in Merino than British breed types.

Banding of the fleece in black sheep, so that the staple shows alternate bands of pigmented and unpigmented wool, is also an early and characteristic sign.

The anaemia and excessive scouring, associated with a fairly severe degree of copper deficiency, occur particularly in the breeding ewes and are noted, generally, only during the winter months. Obviously both anaemia and scouring may be due to many other causes; the occurrence of these manifestations therefore has no diagnostic significance.

Lambs, born of mothers maintained on copper deficient locations, may show a disease, named ataxia. This name refers to the characteristic manifestations, an incoordination of gait.

This disease, resulting from a low copper status, affects lambs from birth to when about four months old. Typically there is some check in growth followed by a loss of control of the hind legs. This, at first, is noted during driving, when movement becomes progressively more difficult. Finally the hind quarters sway ("sway back") and the affected lamb falls over and is only able to proceed again after resting. The condition gets progressively worse until in the course of days or weeks the lamb can travel only short distances or not at all.

The characteristic inco-ordinated gait (ataxia) results from degeneration of the nervous system and should not be confused with the stiffness and lameness seen in arthritis, an infectious disease.

More rarely copper deficient lambs are born dead, or are affected at birth or when a few days old with a rapidly fatal disease in which there are signs of brain involvement. In general the earlier the lamb is affected the more rapid and fatal is the course of the disease. Usually, under Western Australian conditions, lambs do not show signs until about four to eight weeks

old; these may survive for weeks and, although the majority may die, others may grow to maturity. Some abnormality of gait, however, almost always persists.

The numbers of lambs affected and the course taken by the disease is related to the degree of copper deficiency and may vary considerably from year to year, particularly in areas not severely deficient. It has been shown quite definitely that a degree of deficiency insufficient to cause ataxia may, however, retard the growth and development of lambs to quite a marked extent.

Copper Deficiency in Horses and Pigs.

No detailed investigations have been made of the conditions affecting foals and young pigs, which are attributed to copper deficiency. There seems to be no doubt, however, that the abnormalities referred to do result from this deficiency and are prevented by copper supplementation.

Foals.—The so-called "rickets" which was formerly commonly seen, particularly in thoroughbreds, in the Gingin and Dandaragan districts, was characterised by unthriftiness, depressed growth rate and in

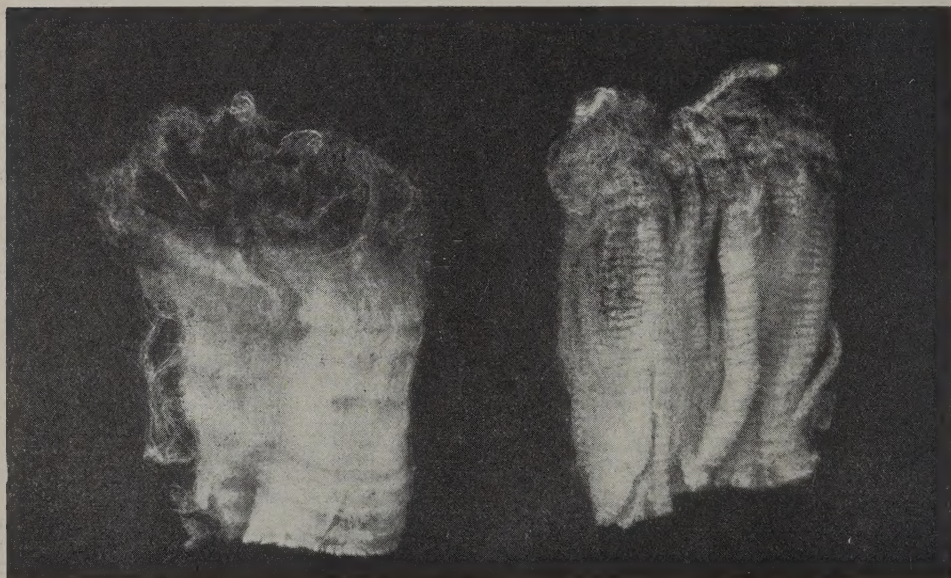


Fig. 4.—"Stringy wool" from West Mt. Barker is shown on the left. On the right is normal wool from a copper top-dressed location at Dandaragan

the more severe cases, by pronounced stiffness of the limbs which were commonly held in various abnormal positions due to bending at the joints. The bones themselves did not bend as in true rickets (rachitis), but the development of bony enlargements ("apple joints") was a not uncommon sequel. Affected animals tended to stand up on their toes. This condition was sometimes apparent at birth, or became manifest during the succeeding six months. It did not develop after weaning, although animals tended to grow slowly until about two years old.

The disease was sometimes fatal, but stockowners found that its progress could be arrested by stable feeding mother and foal with dry feed, grown locally.

Pigs.—Bennetts and Beck (1942) reported the occurrence of an ataxia in young pigs, similar to that affecting lambs, associated also with a low copper status. This condition was commonly seen in the severely copper deficient region of the lower South-West prior to the widespread use of copper fertilisers. Copper supplements given in the form of licks or as food additives have apparently given complete control. Although this disease was incompletely studied there seems little doubt that it was a manifestation of copper deficiency. Observations in South Australia reported by Wilkie (1959) appear to provide suggestive confirmatory evidence.

Post Mortem Appearances.

The carcasses of animals affected with copper deficiency do not show any striking or characteristic appearance on post mortem examination. In lambs, however, the skeleton may be rather poorly developed—the shafts of long bones are thin and brittle and there may be spontaneous fractures of the ribs.

The microscopic examination of tissues however, may reveal marked changes, notably degeneration of the nervous system (demyelination) in lambs and pigs; this degeneration accounts for the characteristic inco-ordination of gait. No such changes have been seen in cattle, which do not show ataxia. Cattle, as we have indicated, may show marked heart abnormalities with loss of muscle and its replacement by scar tissue (atrophy and fibrosis). Some evidence of fibrosis may be obvious to the naked eye but generally microscopic

examination is necessary to detect changes which, however, may be profound.

Control.

As a deficiency of cobalt, not uncommonly, occurs concurrently with that of copper it is convenient to consider the control of both together in a separate section at the end of this article.

B.—COBALT DEFICIENCY

Investigations carried out in this State, in South Australia, and more recently in other parts of the world, have demonstrated that minute amounts of the element cobalt are necessary for the growth and health of the ruminant animal. If the diet contains less than the exceedingly small minimal requirement, sheep and cattle will not thrive and may waste and die. Horses and other non-ruminant animals, however, do well on cobalt deficient pastures which will not maintain sheep and cattle.

As cobalt is not needed by plants we may have the anomalous spectacle of these animals dying, apparently from starvation, although grazed on luxuriant pastures. This was the case at Denmark until Filmer and Underwood determined the cause of "Denmark wasting disease."

Recent investigations indicate that the ruminant animal needs cobalt because this element is used by the microscopic organisms (rumen flora) which live in the paunch, and there build up certain nutrients (notably Vitamin B12) which are vital to the welfare of these animals. For this purpose the animal must eat regular supplies of cobalt. Any reserves which are stored in the liver are valueless for the purpose; injected cobalt is ineffective. As reported by Lee (1951) sheep receiving by the mouth 7 milligrams of cobalt once a week remained in excellent health; sheep receiving 21 mg. once every three weeks were not so thrifty, whereas others receiving 35 mg. once every four weeks developed typical signs of deficiency and some died.

Cobalt deficiency was responsible for serious mortalities of dairy cattle in the Denmark district, particularly following the establishment of group settlements in that area after World War I; it has also been responsible for the death of large numbers of sheep and cattle from "coast

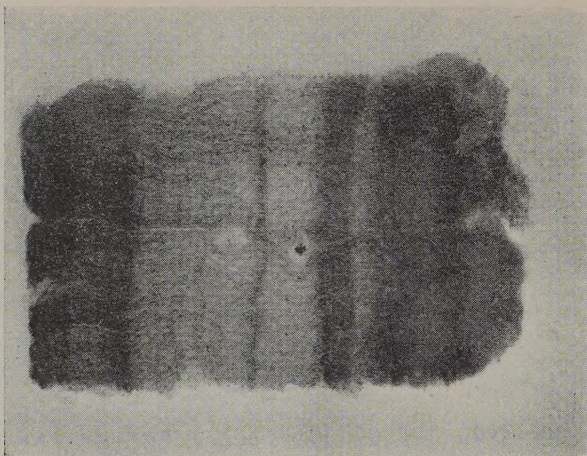


Fig. 5.—Banded black wool
from South Australia
—Photo by courtesy of
Prof. E. J. Underwood

disease" which has been known since the earliest days of settlement of the State.

It is now recognised, however, that the distribution of cobalt-deficient areas is more extensive and that there are regions where the degree of deficiency is less severe and frequently does not lead to death, but merely to suboptimal growth and production. The occurrence of this marginal deficiency is not always easy to confirm. The estimation of the cobalt content of the liver does give some indication of the amounts available in the diet, but the test has limitations. In cases of marginal deficiency it must be interpreted in conjunction with other criteria, notably the symptoms shown, the region and type of country, or the demonstration of the animals' response to cobalt supplementation; this is extraordinarily dramatic where a significant deficiency exists.

Survey work in relation to these considerations has been carried out in the South Western districts, since 1938, and has given a reasonably sound basis for general recommendations for the use of cobalt supplements in the South West Division of the State.

The Signs of Cobalt Deficiency in Animals.

The signs of cobalt deficiency exhibited by sheep and cattle are essentially similar. Young growing animals are more susceptible than adults. Where the degree of deficiency is only slight, that is in

"marginal" areas, the signs may be rather indefinite, these being restricted to sub-optimal growth and development in young animals. This may be more apparent in some seasons than others.

Where a marked deficiency occurs there is a more or less rapid loss of condition and weakness, resulting from decreasing appetite. The animals literally starve themselves to death. In cattle there is a depraved appetite for rubbish such as bark, sticks, bones, earth, etc., and the coat becomes long and rough. In young calves, scouring is often noted. In cows, lactation is suppressed, abortion may occur, and stocking may be difficult.

In affected animals, anaemia is pronounced in later stages of the disease. In sheep, "weepy" eyes are notable and wool growth is depressed; in the later stages there is a definite break in the staple and the wool pulls out easily. Both cattle and sheep become weaker, and if not treated may die within two or three months or so after symptoms are first noted. The disease runs a much more rapid course in sheep and calves than in older cattle. It may occur at any time of the year, but is more common during the spring and early summer when green feed is abundant.

Many diseases, for example starvation, worm infestation, tuberculosis, etc., may cause similar signs to these outlined above. The following may be of assistance in determining whether a disease characterised

by loss of condition and weakness is due to cobalt deficiency:—

- (1) The deficiency disease occurs in the presence of ample feed of apparently good quality, and is most common when the herbage is green.
- (2) Horses are never affected, whereas sheep and cattle are.
- (3) Young cattle, especially those between six and eighteen months are more susceptible than adults.
- (4) Sheep, and lambs especially, are even more susceptible than young cattle.
- (5) The response to cobalt supplementation or to a change to "sound" country is dramatic—affected animals regain their appetites almost immediately and within a day or two become obviously "brighter" and stronger.

Response to the administration of "cobalt bullets," now generally recommended for control, may serve as a valuable practical method of confirming a diagnosis of suspected cobalt deficiency.

The Distribution of Cobalt Deficiency.

On the evidence available it appears that cobalt deficiency is almost entirely restricted to the more coastal areas.

1. *The severely affected areas, where it is, in general, impossible to maintain stock without the use of cobalt supplements are the following:—*

- (a) The Denmark region—the karri soils of the South-West, despite their rich appearance and loamy texture, are notably deficient.
- (b) The "calcareous littoral"—the fine calcareous sands and limestone of the coastal fringe, throughout, are constantly deficient in cobalt (as in copper *q.v.*).

2. *Cobalt deficiency is more patchy in distribution and more variable in degree in the following areas and types of country:—*

- (a) The banksia, tuart and jarrah sands appear to be fairly generally deficient and stock maintained on these types of country commonly show marked signs of deficiency e.g. at Muchea, in the

vicinity of Perth, at West Murray and around Bunbury (copper deficiency is also present).

- (b) Plain country adjacent to the South coast notably in the vicinity of Albany may be more or less severely deficient.
- (c) The jarrah-redgum sands and gravels. Harley and Beck (1958) have reported varying degrees of cobalt deficiency from indefinite to fatal on this type of country from the vicinity of Busselton to Karridale, but the distribution appears to be patchy. (This is the region which is so severely deficient in copper "the falling disease region").

It seems evident that jarrah-redgum country within 15 miles or so of the coast should be regarded with suspicion; similar country further inland, however, has only rarely been found to be cobalt deficient.

It is most probable that intrusions of alluvial soils, as for example at Capel, would prevent the occurrence of cobalt deficiency on properties consisting otherwise of the above types of country.

Cobalt supplementation is essential for sheep and cattle which are maintained on Types 1 (a) and (b); is a fairly general necessity on Types 2 (a) and (b); its use



Fig. 6.—A lamb suffering from ataxia, resulting from a low copper status (Mt. Barker)

may be advantageous on many locations on Type 2 (c) where a marginal degree of cobalt deficiency appears to be widespread.

The methods of supplementation will be discussed in a separate section at the end of this article.

C.—“COAST DISEASE”

A DUAL DEFICIENCY OF COPPER AND COBALT

From the earliest days of settlement it has been known that sheep and cattle could not be run continuously on much of the coastal country; generally within a few months they developed “coast disease.” It has been a common practice to graze large coast runs during the autumn and early winter months with stock, particularly cattle, which have been depastured further inland on “sound” country during the rest of the year. Sheep and cattle did very well for a short period on the natural herbage on the coast, but if left too long droving was frequently difficult on account of a “tail” which became too weak to travel. If left still longer animals died from coast disease. It was noted, however, that even badly affected stock recovered rapidly when they reached the “clay” country further inland.

Investigations carried out in South Australia by Marston *et al.* (1938) demon-

strated that “coast disease” was a manifestation of a dual deficiency of cobalt and copper. It was subsequently confirmed that “coast disease” in this State was an identical condition due to the same cause.

The manifestations of “coast disease” in sheep and cattle, generally, are essentially those of cobalt deficiency, namely progressive wasting and weakness associated with loss of appetite. If the animals live long enough and the liver stores of copper are depleted, sheep show “stringy wool” and ewes may give birth to ataxic lambs; in rare instances sudden deaths in cattle, simulating “falling disease” have been reported from coast runs. These deaths presumably resulted from the effects of severe copper deficiency but there has been no opportunity of confirming this. These mortalities have been reported only in cattle changed to the coast from the severely copper-deficient country in Gingin and Dandaragan—such losses have not occurred since the use of copper supplementation has been general there, and since cattle have been fed both copper and cobalt on coast runs.

As we have indicated, the dual deficiency of copper and cobalt is not restricted to the calcareous sands of the coastal fringes but “coast disease” may occur somewhat further inland.

PART 2.—THE CONTROL OF COPPER AND COBALT DEFICIENCIES IN ANIMALS

THE manifestations of copper and cobalt deficiency can be prevented by the administration of appropriate mineral supplements given singly, or together where a dual deficiency exists. The choice of the means of supplementation to be adopted will depend upon environment, methods of stock management, and upon economic considerations.

It must be borne in mind also that cobalt is needed by sheep and cattle at frequent intervals, preferably daily. Large doses may result in increased liver storage but such stored cobalt is of no value to the animal. On the other hand copper which has been stored in the liver is available to the animals so that they may still thrive even when this element is given at more infrequent intervals. A

regular intake of both copper and cobalt, however, will give the best results.

The copper and cobalt content of pastures, grown in deficient areas, can be raised to normal levels by topdressing with appropriate compounds incorporated with the superphosphate fertiliser. This is certainly the method of choice if practical and economic considerations warrant its adoption; all grazing animals are then

assured an adequate and regular intake of their mineral requirement.

Under many circumstances, however, it is necessary or desirable to use other methods of supplementation:—

- (a) By the use of "cobalt bullets."
- (b) By the use of licks.
- (c) By the addition of solutions or mixtures of minerals to the food.
- (d) By drenching with solutions.
- (e) By administration in drinking water.
- (f) By the injection of special copper preparations.

THE AMOUNTS OF COPPER AND COBALT REQUIRED BY ANIMALS

1. COPPER.

Sheep require a total daily intake of about 10 milligrams of copper. As the amount consumed, each day, from deficient pastures will be of the order 2-5 mg. it is recommended that a daily supplement of 8 mg. be given. This amount is equivalent, approximately, to only one forty thousandth of an ounce. **Eight ounces of copper sulphate will provide the requirement for 1,000 sheep for one week.**

Cattle need about 10 times the sheep dose so that 8 ounces of copper sulphate will provide an adequate supplement for 100 head for one week.



Fig. 7.—A sheep showing typical cobalt deficiency symptoms (Mt. Manypeaks)

Pigs and Horses. There is no definite information of the requirements of these animals, but we have recommended that pigs receive the same amounts as sheep. If brood mares and foals are maintained on topdressed pastures the latter do not, in our experience, show the signs attributed to copper deficiency.

Copper is a poison and must be used with caution. Sheep, in particular, are susceptible to copper poisoning; they may accumulate dangerous amounts in the liver if given an intake higher than that recommended, or if copper storage by the animal is facilitated by other factors which cannot be considered here.

In a number of instances, in this State, serious mortalities have been experienced where sheep were run on copper topdressed country and were at the same time given free access to salts containing copper. **Only one method of supplementation should be used at the one time for sheep.**

2. COBALT.

The daily requirement of cobalt, for sheep and cattle, is very much lower than the copper requirement. The minimum requirement of sheep is exceedingly minute, approximately one-tenth of a milligram (equivalent to approximately one three hundred thousandth of an ounce).

It is recommended, however, that when pastures are deficient, sheep should receive a supplement of 1 mg. daily and cattle 10 mg. daily. On that basis **one ounce of cobalt sulphate or cobalt chloride will provide an adequate supplement for at least 1,000 sheep, or for 100 cattle for one week.**

Cobalt, unlike copper, is not very poisonous and the doses recommended, although on the generous side, are very considerably below the toxic level.

SUPPLEMENTATION WITH COPPER AND COBALT

1. TOPDRESSING OF PASTURES.

Copper.—Topdressing with copper compounds, to raise the copper content of pasture to normal levels, is certainly the ideal method in the more severely deficient areas, and where improved pastures or crops are grown. Under these circumstances the resultant increases in cereal yields and the increased bulk and improvement in pasture quality amply justify the expenditure involved.



Fig. 8.—Cobalt deficient sheep at Mt. Manypeaks

In the very severely deficient areas of the South West improved pastures, notably subterranean clover, cannot be maintained without the use of copper fertilisers. Topdressing with copper, during recent years, has become almost universal in that region, and also in the Gingin, Dandaragan and some other districts.

Animals maintained on treated pastures remain healthy although some care must be exercised in maintaining the copper status of the pasture at a sufficiently high level to prevent the occurrence of "stringy wool."

In most affected areas it has been found that a dressing of 5 lb. bluestone per acre or an equivalent amount of copper ore applied with superphosphate is adequate for 2-3 years both for pasture and animal requirements, although it is often necessary to recommend more frequent dressings for the growth of cereal crops.

Information from South Australia and elsewhere, however, indicates that much heavier topdressings are required on the calcareous sands of the coast, and that it may be ineffective as well as unprofitable to topdress areas of unimproved country carrying native herbage. Again it may not be economic to topdress large areas of de-

veloped country where only a "marginal" deficiency of copper exists.

In these cases other methods of copper supplementation must be considered.

Cobalt.—Topdressing with cobalt to supply the cobalt requirement of the animal through the pasture would appear to be the most effective and certain method of control and has much to commend it on locations where the degree of deficiency is severe and where pastures are highly improved and productive.

Where the deficiency is less severe, perhaps only seasonal in occurrence, and where the production per acre is not high it cannot be justified because of economic considerations. As we have already pointed out cobalt is not a plant food, so topdressing does not in any way benefit the pasture and the costs are of course very much higher than those involved in supplying the minute amounts of cobalt needed when given directly to the animal. Topdressing with cobalt is used extensively in New Zealand and in other parts of the world to control cobalt deficiency in sheep and cattle but it has, as yet, been used only to a limited extent in this State, even at Denmark where the deficiency is severe and where pastures are highly productive.

On the information available it seems that a topdressing of four ounces of cobalt chloride or cobalt sulphate per acre should be effective for two years on most soil types. Topdressing of the calcareous coastal sands, however, cannot be recommended; this would be of doubtful efficiency and would in any event be uneconomic.

2. "COBALT BULLETS."

Administration of the "cobalt bullet," recently evolved and patented by the C.S.I.R.O., promises to be the ideal method of controlling cobalt deficiency under conditions where topdressing is uneconomic.

In principle the bullet consists of a heavy pellet composed of a compressed mixture of a cobalt oxide and a filler. When given by the mouth this heavy pellet lodges in the ruminant stomach (reticulum), slowly releasing minute but adequate amounts of cobalt for many months.

Cobalt bullets for sheep have now been on the market for some time and their efficiency is established. (Experience has shown, however, that they should not be given to lambs under four weeks of age). Suitable guns, for administration, are also available.

More recently cobalt bullets have been developed for cattle and these are now available. Present indications are that they too are effective. They should prove particularly valuable for use on coast runs where the provision of adequate cobalt supplementation often presents some practical difficulties.

Note.—The "bullet" method is not available for the control of copper deficiency.

3. LICKS AND SOLUTIONS

Under conditions occurring in this State, with the exception of the coastal runs which present special practical problems, to be considered later, it has been found generally appropriate to control copper deficiency in sheep and cattle by means of topdressing. The use of licks for sheep, however, may be preferred under some circumstances. Cobalt deficiency in dairy cattle has been controlled largely by the provision of supplements given in the feed, or by licks; relatively few sheep are, as yet, carried in the more severely cobalt deficient regions but licks should provide reasonably effective control, where required.

It must be borne in mind that young stock are more susceptible to cobalt deficiency than older animals. It is therefore, very important that they receive a regular supplement.

In preparing solutions of copper and cobalt non-metal containers, of glassware, enamel, or earthenware, must be used.

Licks

Copper.

The licks recommended for sheep in the past have been:—

(a) Bluestone (copper sulphate) $\frac{1}{4}$ – $\frac{1}{2}$ lb.; Salt, 100 lb.

The bluestone is dissolved in rainwater, the solution sprayed on the salt and thoroughly mixed to incorporate the bluestone throughout. In view of the real danger of copper poisoning from an excessive intake it is now recommended that the concentration or intake of the lick be adjusted so that sheep do not eat more than the amount recommended, that is not more than eight ounces of bluestone per 1,000 sheep per week.

(b)—Denmark Lick, which contains 0.6 per cent. of bluestone, has been sometimes used for the same purpose. The concentration of copper in this lick is such that 80 lb. of lick will provide a copper supplementation for 1,000 sheep for 1 week.

Cattle could be fed either of the above licks at a dose rate of 10 times that recommended for sheep as set out below.

Denmark lick has also been used to prevent ataxia in young pigs fed at the rate of $\frac{1}{2}$ to 1 oz. per week.

For pigs the use of a salt and copper mixture added to the feed has been advocated by Departmental officers for use in the copper deficient areas of the South-West. It is reported as being safe and effective.

A mixture containing 8 oz. bluestone to 100 lb salt is prepared as directed above.

For use $\frac{1}{2}$ lb. of this mixture is added to each 100 lb. of feed. (The mixed feed so prepared will contain approximately 5 parts per million added copper.)

Cobalt.

(a) Denmark Lick.—Since the investigations of Filmer and Underwood (*loc. cit.*) a lick containing limonite, a selected ore containing cobalt (500 p.p.m.), has been

widely used for the control of cobalt deficiency in cattle, either mixed in graded doses with feed in the bail, or offered freely in the paddock. This lick consists of two thirds limonite and one third salt, with 0.6 per cent. bluestone added. It has been used also for sheep.

The dose rate recommended is:—

Cattle—1-2 oz. per day.

Sheep—1 oz. per week.

It will be noted that this lick supplies both cobalt and copper requirements.

(b) Cobalt-Salt Lick.—A simple lick containing cobalt and salt may be compounded by the stock owner using—

Cobalt chloride or cobalt			
sulphate	....	....	2 oz.
Salt	....	....	100 lb.

This will contain an amount of cobalt approximately equivalent to the Denmark lick, so that the consumption by cattle of 1-2 oz. daily, according to age, or by sheep of 1 oz. per week will be effective in preventing cobalt deficiency.

The control of mineral deficiencies by giving stock free access to appropriate licks is open to a number of objections. The consumption of licks by animals may be variable, some animals not taking enough to correct the dietetic deficiency whereas others may take excessive quantities. The palatability of salt licks, containing mineral supplements, may vary considerably with

locality—in some regions salt is eaten avidly by stock, in others, as near the coast, animals may be entirely disinterested. Too frequently also no measures are taken to shelter lick troughs from weathering with the result that the effectiveness of the lick may be lowered because of the leaching out of active constituents. Licks, in general, seem to be taken more readily by sheep than by cattle.

The Use of Solutions

The drenching of animals to control mineral deficiencies has only a limited application but it may be convenient to make use of solutions administered on feed particularly in the control of cobalt deficiency in dairy cattle; this is obviously a very effective method of control where applicable.

The amounts to be used can be based, again, on the fact that 1 oz. of cobalt sulphate or cobalt chloride contains enough cobalt for 100 cattle for one week.

Copper Solutions.—It may be advantageous occasionally to drench sheep with a copper solution which will be stored in the liver and so be effective for some weeks, as for example in the case of lambs which are showing early signs of copper deficiency, or of ewes forward in lamb to prevent the possible occurrence of ataxia in the progeny—this in cases where other methods of supplementation, for some reason, have not been adopted.



Fig. 9.—These sheep are suffering from "coast disease." The animal in the foreground is showing improvement after being treated with copper and cobalt

To prepare a suitable solution for the purposes indicated dissolve 8 oz. of copper sulphate in 1 gallon of rain water. Give sheep **one** drench of the following amounts:—

Lambing ewes—20 c.c.

Lambs over 4 months—5-10 c.c.
under 4 months—5 c.c.

Cattle— $\frac{1}{2}$ pint.

Cobalt Solutions.—To prepare a suitable cobalt solution dissolve 1 oz. of cobalt sulphate in 1 gallon of rain water. This solution may be given as a drench or given with concentrates, or in the case of calves added to the milk.

The required doses are:—

Cattle—

Adults—30 c.c. (1 fluid oz.) daily.

Calves—15 c.c. ($\frac{1}{2}$ fluid oz.) daily.

(**Sheep**—If it is desired to treat sheep with cobalt solutions this may be conveniently carried out by the use of methods detailed under “coast disease,” **omitting the bluestone** from the solutions recommended in that section.)

4. INJECTION OF COPPER COMPOUNDS.

Various workers have investigated the possibility of controlling deficiency by injection under the skin (or into the muscles) of non-irritant compounds of copper, such as copper glycinate, incorporated in a waxy or oily vehicle. A considerable proportion of the injected copper is absorbed and transported to the liver. It seems that two or three doses a year may serve to maintain an adequate copper status in treated animals.

The methods used in New Zealand have been described by Cunningham (1957 and 1959) but it appears that the method is less satisfactory for sheep than cattle. The preparations are not yet available or recommended for use here but the method may yet play a useful role in the control of coast disease.

THE CONTROL OF “COAST DISEASE”

The control of the dual deficiency of copper and cobalt on the coast runs in this State presents a number of practical problems for which there is as yet no really satisfactory solution. Under most conditions topdressing, as we have indicated,

would be of doubtful efficiency and is impracticable; licks are not readily taken, particularly by cattle; drenching with solutions needs to be carried out preferably once a fortnight or not more infrequently than once a month in order to prevent losses from cobalt deficiency; the provision of supplements in the drinking water, which has been the most favoured method of control, also has many limitations.

The choice of the method or methods adopted to control “coast disease” must depend on the system of management adopted and upon practical possibilities. The alternatives are:—

- (1) Drenching.
- (2) Supplementation of Drinking Water.
- (3) Cobalt Bullets and Copper Administration.

1. Drenching with Copper and Cobalt Solutions.

Lee (*loc. cit.*) for somewhat similar conditions has suggested the following solutions:—

A convenient *stock* solution of copper and cobalt may be prepared by dissolving 1 oz. cobalt sulphate and 8 oz. copper sulphate in one gallon of rain water.

Earthenware, enamelled, or glass containers must be used exclusively, as these solutions destroy iron or galvanized surfaces.

A *dilute* solution, suitable for frequent drenching, is prepared by mixing the stock solution with an equal volume of rain water. The *dilute* solution will contain approximately 8 mg. cobalt, and 60 mg. copper in each 10 c.c.

These may be used as follows:—

Sheep, of all ages, may be drenched:—

- (i) *Dilute solution*—10 c.c. once a week. This will give the maximum response.
- (ii) *Stock solution*—20 c.c. once a fortnight. This will be effective.
—20 c.c. once a month. This may prevent losses from coast disease but cannot be expected to maintain stock in good condition.

Cattle, of all ages, can be treated similarly giving 10 times the above doses, that is stock solution—50 c.c. or 1 $\frac{3}{4}$ fluid ounces once a week. 200 c.c. or 7 fluid ounces once a fortnight (or once a month).

2. The Addition of Copper and Cobalt Salts to the Drinking Water.

It is difficult or impossible to give regular and accurate quantities of these minerals to cattle and sheep through the drinking water. Nevertheless a rather surprising degree of success in the control of "coast disease" in cattle, carried on the coast during the dry period of the year, has been achieved by rather crude means which will be referred to later. A degree of success has also been obtained on some of the northern coast runs where sheep are maintained for long periods on deficient country.

It has been found, however, that stock waters in many deficient areas contain carbonates in solution; these react with both copper and cobalt salts to form insoluble compounds which are precipitated. The supplements are in consequence not taken in by stock when drinking. Another disadvantage is that sheep drink little water in the winter and spring months when green feed is available.

Until recently, no really satisfactory method was available to ensure that the drinking water contained constant and controllable amounts of copper and cobalt salts, added as a supplement. Now this difficulty has been overcome and devices are on the market which will feed in appropriate amounts of a concentrated solution at the ball tap, so that the requisite level of minerals is maintained in the water trough; the prepared solutions are also available commercially.

This should be more effective and practical than the means previously used by stockowners (a) of adding an estimated amount of bluestone and cobalt sulphate to the water trough (frequently wrapped in hessian and immersed below the ball tap), or (b) using two holding tanks, the required amount of supplements being added to the tank used at that time to supply the trough.

The quantities of copper sulphate and cobalt sulphate or chloride to be added to the drinking water are based on the assumption that sheep drink 1 gallon and cattle 10 gallons of water per day.

The required concentration will therefore be:—

Cobalt sulphate or chloride	1 oz.
Copper sulphate	8 oz.
Water	7,000 gallons.

This will provide the needs for 1,000 sheep or 100 cattle for one week.

It should be noted that only cement lined or bitumen painted troughs and tanks must be used because copper solutions corrode metal reservoirs and fittings.

3. Cobalt Bullets and Copper Administration.

On present evidence it appears that the most practical and effective means of controlling coast disease on some of the larger coastal runs may prove to be by the use of cobalt bullets associated with some method of copper supplementation. The bullet will provide the adequate daily intake of cobalt which is essential for the best results. Adequate stores of liver copper could be maintained by the injection of the copper preparations referred to, or less satisfactorily, by an occasional drench with the bluestone solution mentioned earlier.

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Fig. 1.—The Gascoyne Research Station "crowder"—constructed for work in cultivated irrigation soils



OPPOSED DISCS FOR FURROWING IN PASTORAL AREAS

By W. M. NUNN, B.Sc. (Agric.), Officer-in-Charge, North-West Branch

THROUGHOUT our pastoral regions in all land divisions from Murchison to Kimberley, there are extensive areas of bare country which must be broken in some way to enable water penetration and to provide a place for seed to lodge before regeneration of pasture species can be expected. Earlier articles in this Journal have explained the occurrence of these bare areas, and described methods of furrowing. Checkerboard designs have been successful on perfectly level locations but contouring becomes essential where there is a slope of any dimension.

In trial and demonstration work carried out at Meekatharra, Port Hedland and at several points in East and West Kimberley, a range of standard implements have been used and compared. The mouldboard plough did a good job at Port Hedland where working conditions were not heavy, and earlier articles have stressed success obtained using a three-furrow plough with the centre mouldboard removed.

This provided two separate furrows and ridges and offered the largest obstruction to ground level winds of all the implements in use in those trials.

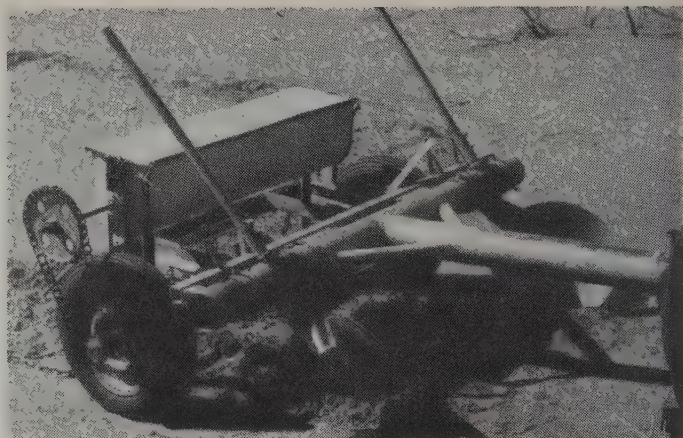
On much heavier soils in Kimberley, where surfaces were baked hard after years without grass, Agricultural Adviser Fitzgerald found that a mouldboard implement simply could not be made to penetrate, and the heaviest disc he could pull made only a scratch on the cement-like surface. Success was achieved here by

waiting till rains had collected in the disc scratching and then re-working over the same lines. Sufficient water had penetrated as a result of the first scoring of the surface, to enable the second operation to open up a suitable furrow.

Agricultural Adviser D. Wilcox, working in the upper Murchison, has tried to apply these lessons but he is up against the toughest conditions of all. Soil surfaces are baked hard and rains are so far between, and so uncertain as to season, that follow-up work would be quite impracticable except perhaps on very restricted areas.

All this experience has led to a good deal of thought by those concerned, on the possibility of special implement design. Massive traction would, of course, do the job anywhere, but then the cost would become so high that the job would not be undertaken.

Fig. 2.—Mr. L. McTaggart's drawn implement with seedbox attached, as used at Bidgemia Station



Most stations now have wheel tractors of some description and the search is for the implement which will make the greatest disturbance to the ground while being drawn by such a tractor at working speed.

An implement assembled at the Gascoyne Research Station with two discs set at opposing angles to crowd soil into a bank, was tried out on hard country, and demonstrated that the balance of the discs against each other enabled them to bite deeper and the machine to run more truly.

In addition to cutting deeper furrows, the discs could be set to the distance apart, varying with the country, which would

aggregate the soil lifted into one ridge and thus leave the maximum obstruction possible to ground level winds and to surface water movement.

There are advantages too, in having a furrow each side of the central ridge. Wind-borne seeds and debris collect best in the furrow on the windward side of the ridge. If there is a furrow on both sides, then all winds are contributing.

On sloping country most water collects and is held in the furrow which is on the uphill side of the ridge. With a furrow on both sides, all lines of work are collecting as well as can be expected, while



Fig. 3.—Mr. A. Robinson's opposed disc plough on hydraulic toolbar under test in black sandy soil

in a standard furrowing operation only 50 per cent. of lines could have the furrow uphill.

The Gascoyne Research Station implement (Fig. 1) was, of course, too lightly constructed for the work. It was designed for crowding banks between irrigation bays working in soil already broken up by standard ploughing. It served however to test the theory in brief practices and as an illustration of requirements to interested pastoralists and machinery manufacturers.

Since then two opposed disc ploughs have been constructed, each on rather different lines, and put to work in pastoral areas.

The first of these was made to the order of Mr. L. McTaggart, of Bidgemia Station. It is a drawn implement and is fitted with

motor car wheels for speedy transport as a trailer unit. It has done many miles of furrowing work this season and, as can be seen from the illustration (Fig. 2), it is fitted with a seeding attachment for sowing Buffel grass as the furrows and banks are formed.

The second unit was made for Mr. A. Robinson, of Beringarra Station, for attachment to the 3-point linkage of a Ferguson tractor, and the illustration (Fig. 3) shows it undergoing trial in an area of black sandy soil. It is now facing much harder work than this at Milgun Station, 100 miles north of Meekatharra.

Mr. McTaggart and Mr. Robinson are to be commended for their initiative in applying so promptly and so effectively the lessons learned in this field.



FORRESTANIA AREA TO BE TESTED

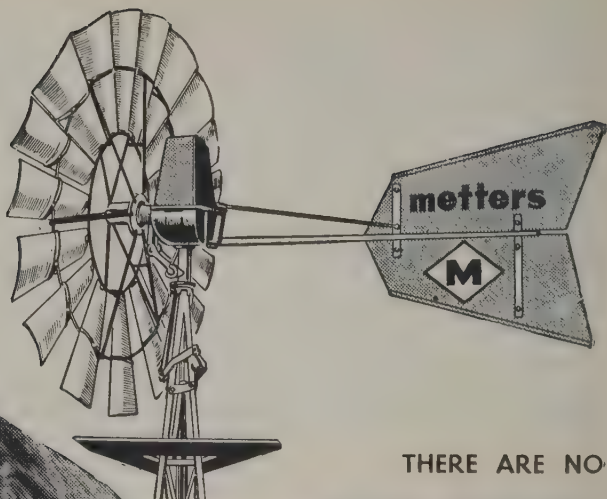
A ten-acre demonstration plot in the Forrestania area has been ploughed and will be fenced in preparation for test sowings of cereals and pasture plants next autumn. The work is being carried out conjointly by the Department of Agriculture, the Kondinin Road Board and the Hyden Progress Association.

In announcing this, recently, the Minister for Agriculture (Mr. C. D. Nalder) said that the news would recall memories of the "3,500 Farms Scheme," an ambitious land settlement project of some 32 years ago. After World War I, arrangements were made for the spending of £34,000,000 of British loan money on land settlement in Australia. The 3,500 Farms Scheme was put forward calling for extensive land settlement of some 8,000,000 acres of land in 12 to 13 inch rainfall country east of the No. 1 Rabbit Proof Fence. Some preliminary road-making, clearing and water conservation was carried out in the area but the project was abandoned when it failed to meet with the approval of a commission charged with investigating all schemes submitted by the States.

The onset of the depression years caused the scheme to be almost forgotten, but not by settlers in the Kondinin and Hyden districts who have constantly pressed for an extension of settlement eastward.

The plot selected, said the Minister is situated about 8½ miles east of the Rabbit Proof Fence on the south side of the Hyden-Forrestania road on light scrub plain country. The Kondinin Road Board has carried out the ploughing and undertaken to plough the land again next year. This body will also transport fencing material to the plot and supply labour to erect the fence.

The Department of Agriculture is supplying the fencing materials, seeds and fertilisers and will be responsible for the sowing of the plots, together with periodic inspection and assessment of results.



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INSECT *Pests* AND THEIR CONTROL

By J. A. BUTTON, B.Sc.(Agric.), L. E. KOCH, B.Sc.—Entomologists

POTATO MOTH CONTROL

THE potato moth, *Gnorimoschema operculella* Zell., is almost world-wide in its distribution and can cause considerable damage to both potato crops and stored potatoes. The adult insect is a small inconspicuous, grey moth. The caterpillars cause the damage and they are, when fully grown, about half an inch long and pale greenish-white in colour. They eat into the leaf and feed between the leaf surfaces and even work down the leaf stalks into the stems. Tubers may be damaged in the ground by caterpillars entering through cracks in the soil.

About 8,000 acres of potato crops are grown in Western Australia, mainly in the South-West and Lower South-Western areas of the State. The crops are grown in three main periods—early (June to mid-July), midseason (mid-July to mid-November), and late (November to April) plantings—the respective acreages being 2,000, 2,000 and 4,000.

It has been found that, when climatic conditions are favourable, potato moth infestation can occur in most potato crops planted in this State. Instances can be cited of growers having lost over 50 per cent. of their crops through the ravages of the pest. Most growers are aware that potato moth can be controlled with modern insecticides but in many instances they neglect to carry out the necessary control measures with the result that heavy losses occur. Other growers who do spray are inclined to leave the first spraying until the pest has become well established and the chances of getting good immediate control are reduced.

SEASONAL OCCURRENCE

Jenkins (1954) says it is "undoubtedly during the dry summer conditions that

the potato moth is most destructive for it is then that the life cycle is completed most quickly and that the dry, cracked soil provides the most ready access to the subterranean portion of the plant. Not only will the moths enter cracks in the soil in search of tubers, but when through drought and grub attack, the potato tops wither and die, the caterpillars will leave the drying foliage and crawl under the clods to attack the crop waiting to be dug."

INSECTICIDE TRIALS

During the last few seasons some growers have reported disappointing results following the use of DDT for the control of potato moth. It was therefore decided to re-evaluate the effectiveness of DDT under local conditions and to test at the same time three newer insecticides. A replicated trial was accordingly planned and laid out at the Wembley Research Station.

Steps were taken to ensure a reasonable moth population. However, this resulted in an unusually heavy infestation and, after an early severe setback, it was considered advisable to re-treat at the first sign of re-infestation. Four applications were made at intervals of nine days. DDT,



Fig. 1.—A. Potato leaflets showing various stages of "mining" by potato moth caterpillar. B. Terminal injury to young potato plant

endrin, dieldrin and "Dipterex" were used at the following rates:—

DDT 20 per cent. emulsion—2 pints of concentrate per acre.

Endrin 20 per cent. emulsion—1 pint of concentrate per acre.

Dieldrin 25 per cent. emulsion—1½ pints of concentrate per acre.

"Dipterex"—1 pint of concentrate per acre.

A knapsack spray was used and spray was applied at about 50 gallons to the acre.

DDT STILL EFFECTIVE

Leaf samples were taken from the plots and the figures obtained from damaged ratings were analysed. These showed that DDT, dieldrin and endrin at the rates used gave good control of potato moth. "Dip-

terex," whilst giving a measure of protection, was inferior to the other treatments at the rate applied.

DDT was the most economical treatment.

A second sampling carried out three weeks after the last application of insecticide failed to show any difference in levels of re-infestation between the treatments although damage had increased in all plots during this period.

At the conclusion of the trial the crop was dug to determine yield from each treatment. All treated plots returned higher yields than the untreated control

plots, but DDT, dieldrin and endrin showed significantly higher yields than "Dipterex."

DISCUSSION

DDT is still able to give satisfactory protection against the potato moth and no supporting evidence for suggested resistance emerged from the trial. Under normal conditions two or possibly three treatments of DDT, thoroughly applied, at the rate of 2 pints of concentrate per acre, should be quite adequate to protect summer crops. Depending on the equipment used and the stage of growth of the crop, the quantities of concentrate quoted above



Fig. 2.—Contrast between plants in a DDT treated and a control plot





Fig. 3.—Shows the general layout of the plots and the contrast in plant growth following the different treatments

would normally be mixed with sufficient quantity of water to ensure a good even cover—this could vary from 10 to 100 gallons depending on whether low or high volume plant was used.

Further work designed to provide more information on protection and residual properties of the more promising insecti-

cides is planned. These will be tested at comparable economic rates.

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FRUIT FLY AT CARNARVON

The matter of efficient fruit fly control is of particular importance to Carnarvon, and it is in the interest of all concerned to put forward a major effort to reduce the pest.

Plants capable of harbouring and spreading fruit fly are numerous in the district and include the African Boxthorn which grows widely as a weed, as well as the many commercial crops of fruit and vegetables. This multiplicity of susceptible plants makes control more difficult and at the same time more than ever necessary. Fortunately, Carnarvon as a region is isolated from other areas harbouring the fly, and encourages the hope that concerted effort will produce a very speedy reduction in fruit fly damage.

Carnarvon and surrounding area has now been gazetted a fruit fly infested area. Systematic baiting and the disposal of ripe and fallen fruits are compulsory in a gazetted area, whether the fly is in evidence or not, and this means that all growers must co-operate or face legal action.

Carnarvon banana and vegetable growers are contributing to the cost of the scheme by levy on consignments of produce, and it is in the interest of the district in general that all should now apply themselves to systematic control routine to see that maximum benefit derives from the effort.

A weed control officer is now stationed in the district and with the help of the Carnarvon Municipal Council a start has been made on the systematic eradication of the African Boxthorn from the town area.

RACES OF BEES

From a Broadcast talk by
R. S. COLEMAN, Officer-in-Charge,
Apiculture

YOU have probably seen bees of various colours working the flowers in your garden. Some have yellow stripes others have orange stripes some have no stripes at all, and are a uniform grey or brown. These colours are the main differences between the main races of bees.

The insects we call the honey bees are spread over the world now, but in the ancient times they were to be found only in Europe and the bordering countries. There are other insects belonging to the same family and very closely related to the honey bees in Africa and Asia. These insects collect and store honey.

Until quite recently, that is only a little more than a century ago, there was almost no movement of hives and breeding stock from country to country. The few hives that were shifted had no effect on the local bees. The bees that were native to any area were adapted to their district and all had their good points but compared with the modern bee, they were poor honey-producers.

North of the Alps, and in France and Britain, lived a bee that has been called the European Brown Bee. South of the Alps and around the Mediterranean, lived a bee with yellow stripes. To the North-East of Europe there was a bee that tended to be grey rather than brown and in the main groups there were many local variations.

Two things started the dissemination of breeding stock. First was the increased knowledge of beekeeping which facilitated the breeding of different strains and races. The other was the advent of acarine mite into Europe where susceptible stocks were often wiped out.

The first bees to be used in the breeding of better stock were the Ligurian bees from the Italian Alps. They were outstanding for their quietness and working ability and it was on this race that all work on the production of better bees is based. So much so, that while many different races were used in building up the modern strains, most bees are still called "Italian" if they have yellow bands. The three main races in use today, are the Italian, Carniolian and the Caucasian.

The Italian bees still carry the three or more yellow stripes, of their Ligurian ancestors. They usually are high-producing bees but because of their mixed forebears, some are poor producers.

A characteristic of the Italian bee is that they have wet cappings, they fill the cell to the top and leave no air space behind the cappings. They are prolific breeders and very strong hives are the rule rather than the exception. This is a good point, because the larger the hive, the more honey it will store, everything being equal. The main exception is when the worker bees are short-lived, in which case a hive can be filled with brood and nurse bees and yet have very few bees in the field.

The other two races, the Caucasians and Carniolians are related to each other, as they belong to the grey-brown Eastern Europe group.

The Caucasians come from the Caucasian Mountains, and the Carniolians from the mountainous area between Austria and Yugoslavia, in fact all the standard races originated from mountain country. The Caucasians and the Carniolians have the same grey-brown appearance, and are very much alike in temper as well. Both are exceptionally quiet, and can be worked on a flow by a beekeeper wearing shorts and a hat without a veil or any real protection, with little fear of more than an occasional sting.

They both have good producing strains and in general, there is little to choose between them. A point of difference is that the Caucasians build a shield of propolis over the entrance to the hive to keep out enemies and the weather, and the Carniolians do not.

If at any time you have occasion to choose bees for breeding stock remember that it is the strain that is important not the race. All can be poor or good producers and all can be particularly quiet.

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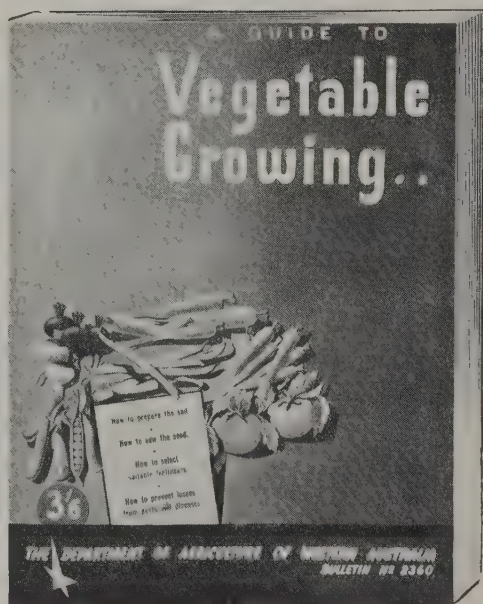
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Fig. 1.—The newly-erected emu fence on the property of J. R. Forrester and Sons, at East Nanson. Note wide belt of clearing on each side of the fence. Apart from serving as an effective firebreak, this cleared strip ensures that emus moving at speed from the adjoining scrubland will see the fence and be less likely to charge into it and cause damage to the netting

Preliminary Investigation into the Control of the Emu in Northern Wheatbelt of Western Australia

By C. D. GOODING, Research Officer, and J. L. LONG, Research Technician

IN a previous article (July-August issue, 1959) mention was made of work undertaken in the northern wheatbelt of W.A. with the object of finding a method of controlling the emu (*Dromaius novae-hollandiae*). In this second article arising from this work, details are given on such topics as food preferences, colour sensitivity, reactions to poisons, regurgitation, etc.

This information is of vital importance in providing the basic information on which to make the final selection of a suitable method of controlling this pest. The subject matter contained herein is dealt with in the following order:—

(1) Bait Media and Preference.

- (a) Place of laying bait material.
- (b) Methods of laying bait material.
- (c) Emus approach to laid bait.
- (d) Baiting materials.
- (e) Grain preference.

(2) Coloured Materials as Attractants.

- (a) Coloured Wheat.
- (b) Coloured Flags.

(3) Vehicle-Food Relationships during winter months.

(4) Use of Agents to Cause Poison to Adhere to Grain.

- (a) Palatability of Agents.
- (b) Paraffin, Glycerol, effects of taste with poisons, etc.

(5) Poisoning.

- (a) Poison periods.
- (b) Poisons used.
- (c) Wholesale Poisoning.

(6) Regurgitation.

(7) Hypnotics.

(1) BAIT MEDIA AND FOOD PREFERENCE

(a) Place of Laying Bait Material.

During the period February-April, 1958, the only places where bait was consumed were along netting fences where emus

emerged from virgin sandplain country to feed among pasture and stubble. Bait laid out in paddocks among the pasture and stubble was passed by with no more than a cursory glance. However, during the months of May to July, following seeding operations, bait laid out anywhere in a seeded paddock where the emus were feeding would be found within a day or two, mainly because of the extreme mobility of the emus while feeding at this period of the year.

From August until late November, interest in laid bait ceased, due to the ripening of crops upon which they preferred to feed. Although on odd occasions isolated baits were consumed there was no sustained interest. In December, 1958, and January, 1959, interest was again established when bait was laid on the edge of crops and along access fences. It was found better to lay bait in the evenings as this disturbed the birds far less and was available to them at daylight the following morning.

(b) Methods of Laying Bait.

At the commencement of this work, bait material was laid in heaps of very short thick trails, both practices proving equally satisfactory. The use of heaps during the winter months was thought to be better because they were more easily seen from a greater distance. Size of heaps and trails was varied, usually from 15 to 30 lb. of bait material being laid per heap or trail depending on the population. Another method attempted was to lay bait in bags,

but this procedure only delayed the "take" of free feed, and the birds ignored the bags if there was bait on the ground. Grain laid on the ground was also preferred to that laid out on bags, which were spread flat on the ground.

(c) Birds' Approach to Laid Bait.

In the first instance the birds' approach was usually characterised by utmost caution and circling of the material. On occasions they would take fright and leap away from the "station," running some ten or fifteen yards. Once they had calmed down and pecked at the bait several times, they usually squatted down around the station, frequently raising their heads to peer about, and also often rising and walking about a few yards away from the bait.

(d) Baiting Materials.

The success of grain as a bait material for emus has obviated much of the necessity of experimenting with other materials. Grain has been the staple diet of these birds for most of the experimental period. Other materials such as bran and pollard baits of various sizes, commercially-made rabbit pellets and quondongs (*Santalum* spp.) have been tried with only a small amount of interest being shown in them by the emus. All alternative materials used were left untouched while grain was available.

(e) Grain Preference.

A wheat and oats preference test was conducted and equal quantities (10 lb.) of both grains were consumed. Close observa-



Fig. 2.—Emus feeding on recently-seeded sandplain country



Fig. 3.—Emus running from an approaching vehicle

tion on a flock of 19 birds revealed a slight preference for wheat. The flock of 19 divided, with birds moving to both heaps; however, those which commenced at the oat heap gradually moved to the wheat heap and stayed until all had been consumed. Following this—but only after a delay of some 15 minutes during which birds examined the vehicle—the oats were completely consumed. Although barley is known to be eaten by the birds it is thought that unless they were feeding solely on that grain there would be no advantage in using it. In all succeeding tests, wheat has been used as the baiting medium. No preference test was conducted using different varieties of wheat, but over the experimental period a number of different types have been used, and cracked and hard grains have been eaten equally as well as soft grain wheats. Most farmers mention that the preference by the emus for soft grain is in the growing crop and this may be tied up with the maturity of the grain itself, as from August-mid-November the birds preferred the seeding heads rather than the grain itself.

(2) COLOURED MATERIAL AS ATTRACTANTS

(a) Coloured Wheat.

Three colours were used as against non-coloured in a preference test lasting ten days. The dye material and amount applied to give the same "relative brightness" were as follows:—

Malachite green $\frac{1}{2}$ oz.—60 lb. wheat.
Coomasine red $3\frac{1}{4}$ oz.—60 lb. wheat.
Ultramarine $\frac{1}{2}$ lb.—60 lb. wheat.

TABLE I

Dye Material	Total Amount Laid	Total Amount Consumed Daily (Progressive) lb.						
		2nd	3rd	4th	6th	7th	8th	11th
Green	45 lb.	....	....	....	* ....	....	2	23 $\frac{1}{2}$
Ultramarine	45 lb.	....	$\frac{1}{2}$ †	$\frac{1}{2}$	4 $\frac{1}{2}$	6	16 $\frac{1}{2}$	42
Red	45 lb.	....	$\frac{1}{2}$ †	$\frac{1}{2}$	1 $\frac{1}{2}$	2	2 $\frac{1}{2}$	32
No Dye	75 lb.	....	10	16 $\frac{1}{2}$ †	38 $\frac{1}{2}$ †	50 $\frac{1}{2}$	57 $\frac{1}{2}$	73 $\frac{1}{2}$

Key : * Heap pecked at.
† Grain relaid 15 lb. heap.
‡ Kangaroo tracks only.

Fifteen lb. heaps were laid, the different colours being grouped around access holes in a netting fence, three replications laid in all. A further test was conducted in which consumed grain was not replaced to ascertain the order in which the different coloured grain was taken.

TABLE II

Dye Material	Amount Laid	Progressive Amount Consumed Daily (lb.)						
		2nd	3rd	4th	6th	7th	8th	11th
Green	15 lb.	N $\bar{U}$	12	12	15	....	..	....
Ultramarine	15 lb.	N $\bar{U}$	*N $\bar{U}$	N $\bar{U}$	6	7	7	15
Red	15 lb.	N $\bar{U}$	*N $\bar{U}$	N $\bar{U}$	13	15	....	....
No dye	15 lb.	15	....	....	....	....	....	....

Key : * Heap pecked at.

As the undyed grain was eaten much sooner than that dyed it would indicate a preference for the natural-looking food. However, after an initial delay coloured grain was eaten, especially if no undyed grain was available.

(b) Coloured Flags.

Sugar bags split lengthwise were dyed red and green and silver (painted with aluminium paint). These were set up on stakes so as to hang waving in the breeze, the object being to attract birds to wheat heaps set out in pasture paddocks. The flags were set up approximately 50 yards apart and about 200-300 yards from a fence line through which a number of birds had been moving regularly. Although the flags were in the paddock for one month and were later tied down to prevent flapping, none of the wheat from the heaps was eaten. Most of the birds continued to feed in the paddock only $\frac{1}{2}$ -mile to the north of the flag sites. On two occasions birds were observed to enter the paddock near the flags. They were reluctant to approach them and bolted after attempting to pass between the red and green sites. During the winter months, white paper set up on a stick and in a growing wheat crop failed to keep the birds away. After a period the paper was completely ignored although the emus altered their approach to the paddock so as not to enter near the site. With enough flags it may be possible, as distinct from attracting them to keep emus from entering a crop temporarily, but the effect would probably be of short duration.

(3) VEHICLE—FOOD RELATIONSHIP IN WINTER MONTHS

Before seeding commenced in April-May, close contact (birds within 10 yards) with the emus had only been made on isolated occasions. At times birds would approach a stationary vehicle which had been in their view for some time. Usually they only stayed a few minutes before being satisfied and returning to feed.

After seeding when they were obviously feeding on seeded grain and that which was spilt during seeding operations, heaps of wheat were placed out with the stationary vehicle in close proximity. The scheme proved an immediate success as birds approached and found the grain. From this first contact a relationship was gradually built up which lasted until the middle of August when natural grasses commenced seeding. It is thought that the "break" in this pattern of behaviour was due to more food becoming available, rather than the use of poisons and hypnotics in tests.

At the "peak" of the relationship, in June—July, the paddock could be entered slowly with the birds in view, the heaps of wheat laid and the vehicle parked. Within $\frac{1}{2}$ to $\frac{3}{4}$ hour the birds would be consuming grain. In some instances the vehicle was driven from the paddock with the emus following some 20 to 30 yards behind. A return to the paddock could be made in the same day and more heaps laid. This in turn would be eaten provided that the birds were not completely satisfied on the first occasion. Although subjected to various preference tests using poisons the birds were loath to forsake this feeding pattern. Any break in the relationship during this period was of short duration—at most lasting three to four days.

It was also found, because of the birds' mobility in search of food at this period of the year (May-August), that heaps could be left out almost anywhere in seeded and pasture paddocks where they were grazing regularly and would be found and consumed within two to three days. Once they had eaten from the heap they usually returned to the same spot on succeeding days. After the first two or three free feeds in the same locality emus were quite often observed running across the paddock towards them in the early morning.

(4) USE OF AGENTS TO CAUSE POISON TO ADHERE TO GRAIN

An alcohol and an oil were tested—glycerol, because of its sweetening effect and paraffin oil because it has neither taste nor smell. Both appeared to hold the poisons and hypnotics used, equally well. Paraffin seemed to remain on the outside of the grain much longer; glycerol because of its hygroscopic nature soon absorbed water and soaked into the grain, which turned a noticeably golden colour in a very short time.

(a) Palatability of these Agents.

To check their comparative palatability, a test was carried out with the two substances applied to wheat. Two 10 lb. heaps were laid out some 10 yards apart, one containing 1 per cent. paraffin, and the other 1 per cent. glycerol. Twelve birds under close observation fed on the heaps and they obviously preferred that containing paraffin and gave no indication that they noticed the oil. Those feeding on the

glycerol heap usually shook their heads after the first mouthful, and then picked up small quantities only to shake it from the beak. All soon moved to the heap containing paraffin and after two hours, 9 lb. of paraffin-wheat and $1\frac{1}{2}$ lb. of glycerol-wheat had been consumed.

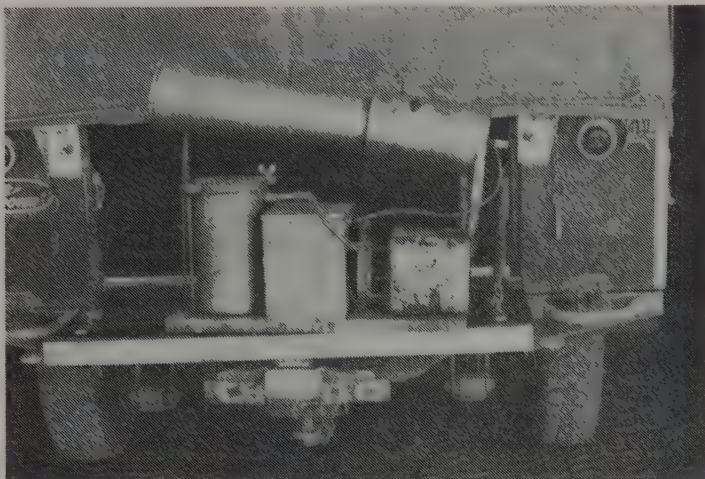
(b) Paraffin and Glycerol with Poisons and Hypnotics.

Both glycerol and paraffin were used with chloral hydrate, cyanide and arsenic pentoxide, and the emus' reactions to such bait was observed. When either chloral hydrate or arsenic was used, bait containing paraffin was definitely preferred. The

tent by the amount of crop planted in the area and also from other competition (birds, stock, etc.), unless an alternative food supply is available.

The April to mid-August period, when natural grasses commenced seeding and were followed by the grain crops coming into ear, proved in this first year to be the best time to attempt to poison the emus resident on the property. From mid-August until the crop had completely dried off after mid-November, the birds showed no interest in grain baits whatsoever. As suddenly as the cessation of grain-eating in August was the return of their interest after mid-November.

Fig. 4.—A bird-scaring device displayed on the tail-board of a Land Rover. This machine generates acetylene gas which, when built up to the required pressure, is exploded with a loud report. Emus soon became accustomed to the noise and paid it little attention



taste and smell of glycerol must have been obliterated by that of the cyanide, as reactions to both heaps of this material were similar.

(5) POISONING

(a) Poisoning Periods.

From February to April, 1958, the only places where free feed was taken were located along the netting boundary fence between the property and the virgin sandplain country. Although poisoning could be carried out during this period the results, even with an effective poison, would be most variable. Free feed was not always eaten regularly during this period as food was available in the form of grain until almost seeding-time. The actual period would probably be governed to a large ex-

During the period from August until mid-November, 1958, isolated heaps of grain were consumed, but birds rarely returned to the same heap twice, making it almost impossible to free feed. This may explain why farmers obtain such poor results, as it is in the latter part of this period when the populations swell with migratory birds, and poisonings are usually conducted. It is also the period when most of the damage is done to grain crops.

(b) Poisons Used.

To-date potassium cyanide, arsenic pentoxide, parathion, yellow phosphorus, strychnine and nitrobenzene have been used without any marked success.

Potassium Cyanide—Doses of from 1 to 4 oz. per 20 lb. wheat have been used with only one known death resulting. Emus

showed much dislike for wheat prepared with cyanide and would repeatedly back away from these heaps. The one death occurred when an emu swallowed a few mouthfuls very quickly. Then followed a spasm during which the bird executed somersaults, attempted regurgitation and wandered drunkenly about. The bird was lost to view when it fell some 20 minutes later some distance away, and was found to be dead at the end of the observational period. Characteristics of cyanide poisoning among those emus affected were—movement of the head up and down, staggered running and walking in circles, violent regurgitation of food and frequently remaining perfectly still for minutes at a time. Most birds appeared to have recovered in about three hours, and certainly none showed any effect of the poisoning following this period. On occasions emus were observed to consume quantities of sand almost immediately after swallowing the cyanide, probably in order to get rid of the taste of the poison. Twenty emus were observed to eat a total of $1\frac{1}{2}$ lb. of grain poisoned with cyanide at the rate of 4 oz. per 20 lb. Most birds regurgitated and soon recovered.

Arsenic Pentoxide.—The initial experiment with this poison was conducted using old As_2O_3 , much of which had been converted into arsenic acid. A dose of 2 oz. per 10 lb. wheat was used and 20 emus were closely observed feeding on the mixture. The characteristic effects of the arsenic on the birds were—violent regurgitation, hunching of neck into body with tail drooping and slow movements (one or two paces at infrequent intervals). One bird regurgitated before rising from the heap and after consuming grain for about five minutes. Further trials were conducted with As_2O_3 and a hypnotic to prevent expulsion of food (see later), but close observations were not possible. The effects of the arsenic appeared to last considerably longer than those for cyanide. Within two hours most of the birds had moved slowly into a patch of scrub and did not appear until 11 a.m. the following day. When they had approached the heaps once more to a distance of 50 yards, they took fright and bolted at high speed back into the scrub. On this occasion, they did not return during the day. One carcass was found a week later, and death was thought to be due

to poisoning with arsenic pentoxide in this test.

Parathion.—2 oz. parathion was mixed with a little water and placed on 10 lb. grain. Sixteen emus were known to feed on the bait laid out in two 5 lb. heaps some 10 yards apart. Some dislike to taste was shown as many birds registered their disapproval after the first few mouthfuls, but within five minutes they had settled down to eating without much hesitation. Reactions observed to parathion were—staggered gait and symptoms similar to hypnotics used, extremely slow movements, much standing still, appearing to stare into space, preening and some squatting down for five to ten minutes. Violent regurgitation among only a few.

Only one death resulted from this test—a 50 lb. half-grown emu was found some five hours after the first bird ate from the heap. Two birds were noticed on the following day to be sick and had adopted the attitude of neck hunched to body and tail drooped down and curled back under body. When chased they ran slowly across the paddock with a staggered gait which did not alter when the vehicle was driven close to them.

Nitrobenzene, Phosphorus and Strychnine.—These tests were carried out after the winter period and close observations were impossible at the time: Nitrobenzene (2 oz. per 5 lb. wheat) gave no apparent results and it is thought that a much increased dose would be needed before any results could be expected. Phosphorus (1 lb. "Grim" per 40 lb. grain) has been used; emus refused to eat any of this mixture, but at the time birds were not keen on taking free feeding and hence the test was thought to be inconclusive. Strychnine (1 oz. per 10 lb. wheat) was tested and six deaths resulted from the use of this mixture. This was the most promising result achieved to-date. Although of course there were many more birds in the area at the time, it is thought that only these six had attempted to eat the poisoned bait.

(c) Wholesale Poisoning.

Although still on a relatively small scale a wholesale poisoning was conducted in late November, on one section of the property. The number of "migratory" birds at that period were reduced, leaving a small "resident" population, but no

evidence of success was found. It was thought that the emus had been frightened away after ingesting the bait, regurgitating and possibly suffering some effects from the poison. Average count figures on the observational area (Long 1959), November 81, December 27, and January 61, tend to substantiate this theory.

Wheat grain was laid as follows—November 11—60 lb.; November 18—80 lb.; March 20—60 lb.; and free feed grain was not replaced until each amount had been consumed. By November 22, all free feed grain laid had been eaten and the following day poison was laid. Arsenic pentoxide at 2 oz. per 10 lb. wheat, with the addition of 1 oz. chloralose to prevent regurgitation was used, the poison and hypnotic being adhered to the grain with 2 per cent. paraffin oil. Most of the 20 lb. poison bait laid was consumed, but sufficient remained to make a further laying unnecessary.

(6) REGURGITATION

Regurgitation of poisoned material has proved to be one of the most important factors which must be overcome before effective poisoning of the emu can be carried out. Expelled material examined during the winter months included caterpillars, grass and weeds, wheat grain and straw, much fluid and in some cases well-worn stones similar to those usually found in the gizzards of domestic fowls. Thus it would appear that the emu has the ability to regurgitate both from the crop and the stomach. It is not certain whether the action of the poison or the actual taste causes this expulsion of food, but it usually happened very soon after ingestion of even slow-acting poison. At the moment it is thought to be caused more by the taste of the material itself. The following is a résumé of regurgitation caused by the different poisoning materials used. All poisons were attached to the wheat by means of paraffin oil.

Potassium Cyanide.—Regurgitation usually followed from 1 to 12 minutes after ingestion of the cyanide and wheat, with those birds which had gulped down large mouthfuls in the 1 to 3 minutes zone. One significant fact from the cyanide tests was that, with the smaller doses of the poison (1 oz. per 15 lb. grain) there was much more regurgitation than with the larger

dose (4oz. per 20 lb.). Also birds had up to three to four spasms in two hours after consuming the poison material. It was not known whether all birds expelled food at every spasm, although those watched closely during the first onset most certainly did so.

Arsenic Pentoxide.—Regurgitation occurred at from five minutes to 25 minutes after ingestion of bait containing arsenic and paraffin. Some birds continued to react at intervals during and up to 45 minutes after consuming bait. Emus were visible for up to two hours following the eating of the poisoned wheat, but no further spasms were observed. One bird, after eating bait for about five minutes while in a squatting position at the heap, developed spasms and expelled much wheat and fluid before it could rise. The bird then ran for 20 yards and stopped, and soon after showed the characteristic symptoms.

Parathion.—Regurgitation commenced from 10 minutes after the first wheat had been swallowed. During the 10 minutes birds had more or less adopted their normal feeding method around the heaps. Only three of 16 known to have eaten bait material were noticed to regurgitate, while most were observed for periods of $\frac{3}{4}$ to $1\frac{1}{2}$ hours. One death resulted from this poisoning. The bird which died some five hours later, was observed to have three spasms during which food was known to be expelled only at the first occurrence.

Other Poisons.—No known regurgitation occurred with the other poisons used, but no close observations were kept on the birds consuming the bait, and it is most probable that it did occur.

(7) USE OF HYPNOTICS

Chloral hydrate (powdered) has been the only hypnotic used solely for narcosis of the birds to date. Doses of 3 oz. per 25 lb. wheat and 8 oz. per 20 lb. failed to produce sufficient narcosis to allow of handling the birds or to permit any closer approach than normal. After consuming treated bait, the birds generally appeared to slow down physically and would stand perfectly still, sometimes for several minutes. Any attempt at a closer approach would result in an apparent return to normal. Sometimes those affected showed less fear when approaching the vehicle.

Both glycerol and paraffin were used with the chloral, and the emus showed an immediate preference for the use of paraffin. Nine birds consumed a 5 lb. heap in five minutes showing no visible signs of disapproval at taste or smell of the chloral. Twenty-four birds then consumed the 5 lb. heap containing glycerol and chloral, but showed some distaste, some of them only eating one or two mouthfuls before moving away. No regurgitation occurred among any of the emus concerned, they being in view for periods of 1 to 1½ hours after consuming the chloral. Used with a poison (arsenic) the chloral

did not seem to prevent all regurgitation as indicated by the stained ground near heaps.

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Gooding, C. D., and Long, J. L. (1959).—Some Notes on the Emu in the Northern Wheatbelt of W.A. *Jnl. of Ag. of W.A.* Vol. 8 (Third Series) No. 4.

ACKNOWLEDGMENTS

Acknowledgment is made of the assistance of Mr. A. R. Tomlinson (Agriculture Protection Board) and Dr. D. L. Serventy, (C.S.I.R.O.) who kindly read the manuscript.

PEDIGREE SEED SUPPLIES

The Minister for Agriculture (Mr. C. D. Nalder) has advised that supplies of pedigree seed of wheat, oats, barley and Wimmera ryegrass will be available for distribution from the forthcoming harvest at the Department's Research Station. Varieties available this season will be:—

WHEAT

(Midseason)—Baroota Wonder (hay variety); Bencubbin; Eureka (rust-resistant); Kondut.

(Early)—Gabo (rust-resistant); Wongoondy (rust-resistant); Insignia 49 (rust-resistant).

(Very Early)—Bungulla.

OATS

(Late)—Algerian.

(Midseason)—Avon; Dale.

(Early)—Ballidu; Kent.

BARLEY

Beecher; Prior.

WIMMERA RYEGRASS

"Merredin" Early Strain.

Prices per bag of three bushels inclusive of rail freight to farmer's siding will be:—

Wheat, 60s.; Oats, 40s.; Barley, 55s.; Barley (pickled seed), 58s.; Wimmera ryegrass, 40s. per bushel.

Prompt attention to orders will be ensured if the following directions are observed by intending applicants:—

- (1) Make early application direct to the Department of Agriculture, St. George's Terrace, Perth.
- (2) Give clearly full name, postal address, and siding to which the seed is to be railed.
- (3) As soon as possible after receipt of account, remittance should be forwarded. Statements are sent out in order of receipt of the application. No definite reservations can be made until the seed is paid for.

BEEF GROWTH RATE STUDIES

A REPORT ON THE "PARDELUP" PRISON FARM TRIALS

By M. CULLITY, Superintendent of Dairying

IN an earlier issue of this Journal (Volume 5 No. 4 page 479), July-August, 1956, there appeared an introduction to the reports on weight change observations made on three properties in Western Australia. The work was undertaken as part of an Australia-wide plan to accumulate data of normal trends in growth under existing conditions as a pre-requisite to designing experiments with various changes in husbandry.

The Australian Meat Board and the Commonwealth Bank assisted with funds for the provision of the cattle weigh-bridges, and to cover incidental costs on a private property.

Reports on the observations on the other properties have already appeared, namely:—

Geraldton—Narra Tarra (Journal of Agriculture of W.A., Vol. 6; No. 4 July-August, 1957.)

Wokalup Research Station (Volume 6, No. 3 May-June, 1957; No. 5 September-October, 1957; No. 6 November-December, 1957.)

Details of the works at Pardelup follow:—

Pardelup, a prison farm of some 10,000 acres of which 1,000 acres are under pasture is situated 18 miles west of Mt. Barker on the Blackwood Road.

The soils are mainly of the Frankland and Bangalup series and are described in C.S.I.R.O. Divisional report 7/50.

The developed pastures are mainly on the Frankland series. Very little of the Bangalup series has yet been cleared although much of the original scrub under the forest trees has been eaten out by stock.

A jarrah association covers the greater part of the property. Jarrah (*Eucalyptus*

marginata) is dominant, with marri (*E. calophylla*), blackboy (*Xanthe-Preisee*) and banksia (*B. grandis*) in minor quantities.

The property has an annual average rainfall of 321 inches (14 year average 1943-56.)

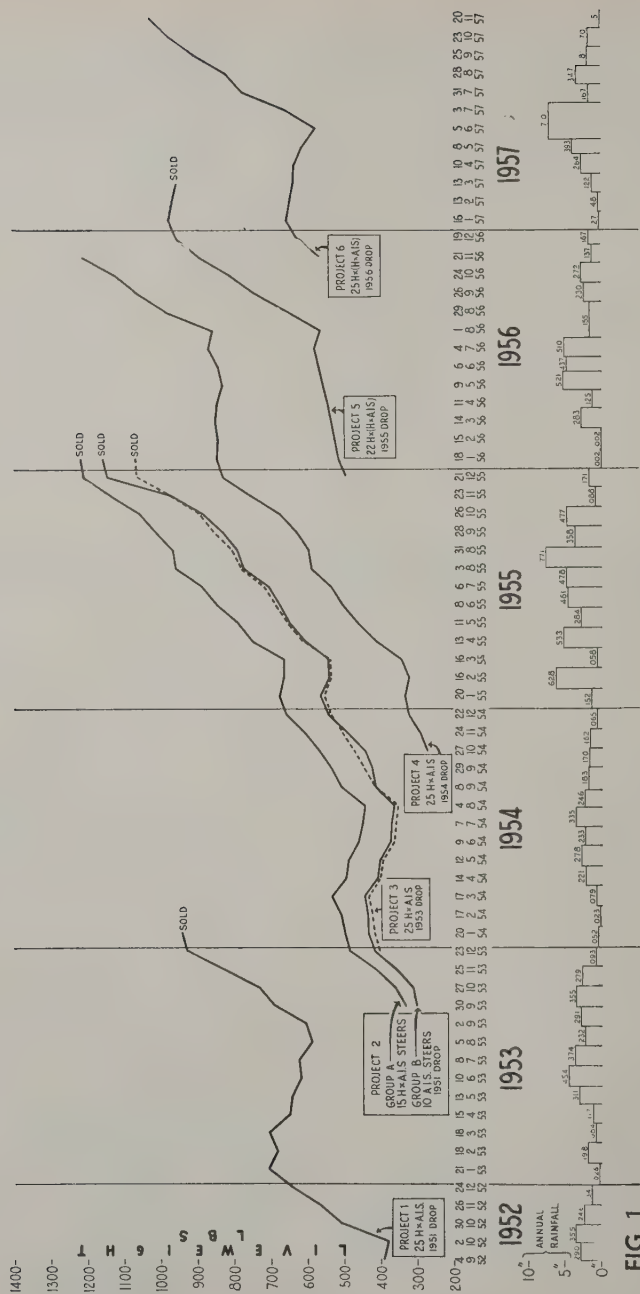
The cattle used were bred on the property. The Australian Illawarra Shorthorn steers were the progeny of the dairy herd while the Hereford (Poll) X Australian Illawarra Shorthorn steers were from a project "grading up" a poll Hereford herd from a foundation of Australian Illawarra Shorthorn cows. (Wherever the word Hereford is used in this report it is to be understood that Poll Hereford is meant.)

No direction regarding management was given for the Projects 1, 2 and 3 in accordance with the general plan to first record trends and rates of gain under existing management.

Weighing commenced on September 4th, 1952, and has continued since at 28 day intervals. The animals are yarded each weighing day about 9 a.m. and weighing completed not later than 10-30 a.m.

The following steers have been used:—

Project 1 (September, 4, 1952-January 20, 1954)—25 Hereford X Australian Illawarra Shorthorn 1951 drop.



Project 2 (September 30, 1953-January 18, 1956)—

Group A.—16 Hereford X Australian Illawarra Shorthorn 1952 drop.

Group B.—10 Australian Illawarra Shorthorn.

Project 3 (December 23, 1953-January 18, 1956)—25 Hereford X Australian Illawarra Shorthorn 1953 drop.

Project 4 (October 27, 1954-December 19, 1956)—25 Hereford X (Hereford-Australian Illawarra Shorthorn) 1954 drop.

Project 5 (December 21, 1955-March 13, 1957)—22 Hereford X (Hereford-Australian Illawarra Shorthorn) 1955 drop.

Project 6 (November 21, 1956-December, 1957)—25 Hereford X (Hereford-Australian Illawarra Shorthorn) 1956 drop.

Details of the weights together with information regarding grazing is given in the accompanying tables.

The trend of growth of the various groups together with details of 28 day rainfall is shown in Fig. 1.

DISCUSSION

(a) Growth Trends.

Except for the 1955 season all curves follow the same pattern—i.e., a period of rapid growth during the spring and early summer followed by a short static term and then a period of declining weight. In 1953 and 1954 the periods of declining weight were lengthy and resulted in slow overall growth.

In Project 1, one period of rising weight ended in January 1953, at an average weight of 706 lb. The cattle then lost weight and did not recover their losses till the weighing on September 30. The lowest weight, 590 lb., was recorded on August 5. From that date till January 20, 1954, a gain of 350 lb. in 168 days was recorded with a top average weight of 940 lb.

In the following year the animals in Projects 2 and 3 lost weight from March 17 to August 4, a period of 140 days.

During 1955 however, due to the early germination and excellent growth of pastures following heavy abnormal rains in

February the cattle in Projects 2 and 3 gained weight throughout the remainder of the year till the time of their sale on January 18, 1956.

Those in Project 4 grew in a comparable manner throughout 1955, and had a static period from January to June 1956, following which they grew rapidly till sold in November. They gained 365 lb. in 168 days, i.e., at a rate of 2.1 lb. per day.

Project 5 animals in 1956 had a set back during one month only, when they lost weight from 581 lb. on July 4 to 562 lb. on August 1. They recovered to 652 lb. by August 29. The high gain of 90 lb. recorded for the 28 days, August 1 to August 29 was probably not a true gain but due partly to lack of fill on bush grazing at the former date.

In 1957, the steers in Project 6 lost weight from January 16 (654 lb.) to June 5 (575 lb.) but recovered quickly and gained to 975 lb. by October 23. An apparent gain of 400 lb. in 140 days (2.8 lb. per day) was recorded.

(b) Rate of Growth.

Despite the prolonged period in the early projects when weight was static or declining, the rate of growth when conditions were favourable was very satisfactory. An examination of the tables will disclose the frequency during spring months when more than 2 lb. and sometimes more than 3 lb. gain per day was recorded.

The periods when gains of this magnitude were obtained were irregular and generally short, due undoubtedly to the frequent alternations from bush paddocks to good pasture.

Weight gains appeared particularly rapid when the cattle were put onto good feed after a period of losing weight. This possibly was associated with differences of fill on bush feed and on good pasture.

Increases were the most rapid in Projects 3, 4, 5 and 6, but still more rapid in Projects 5 and 6 than in 3 and 4. This undoubtedly was due to a gradually improving feed position and probably a little more careful husbandry.

(c) Hereford X and Australian Illawarra Shorthorn.

In Project 2 there was an opportunity to compare growth rates of Hereford X

Australian Illawarra Shorthorn and grade Australian Illawarra Shorthorn steers from September 30, 1953 to January 18, 1956.

The cattle used were all bred on the property and included 15 Hereford X Australian Illawarra Shorthorn and 10 Australian Illawarra Shorthorn steers from the dairy herd.

The average weights at commencement were 335 and 303 lb. respectively. They grew to 1,217 lb. and 1,048 lb. respectively at the conclusion of the trial, the gains

being 882 and 745 lb., the margin being clearly in favour of the Hereford crosses. This result was contrary to that at the Wokalup Research Station, where in a series of comparisons the Australian Illawarra steers gained weight at least as rapidly as Hereford crosses.

For example in Project 3 at Wokalup, 30 Australian Illawarra Shorthorns and 20 Hereford X Australian Illawarra Shorthorns both from Pardelup in the period from June 4, 1953 to January 14, 1954, 224 days put on 453 lb. (2.02 lb. per day) and 417 lb. (1.81 lb. per day) respectively. In

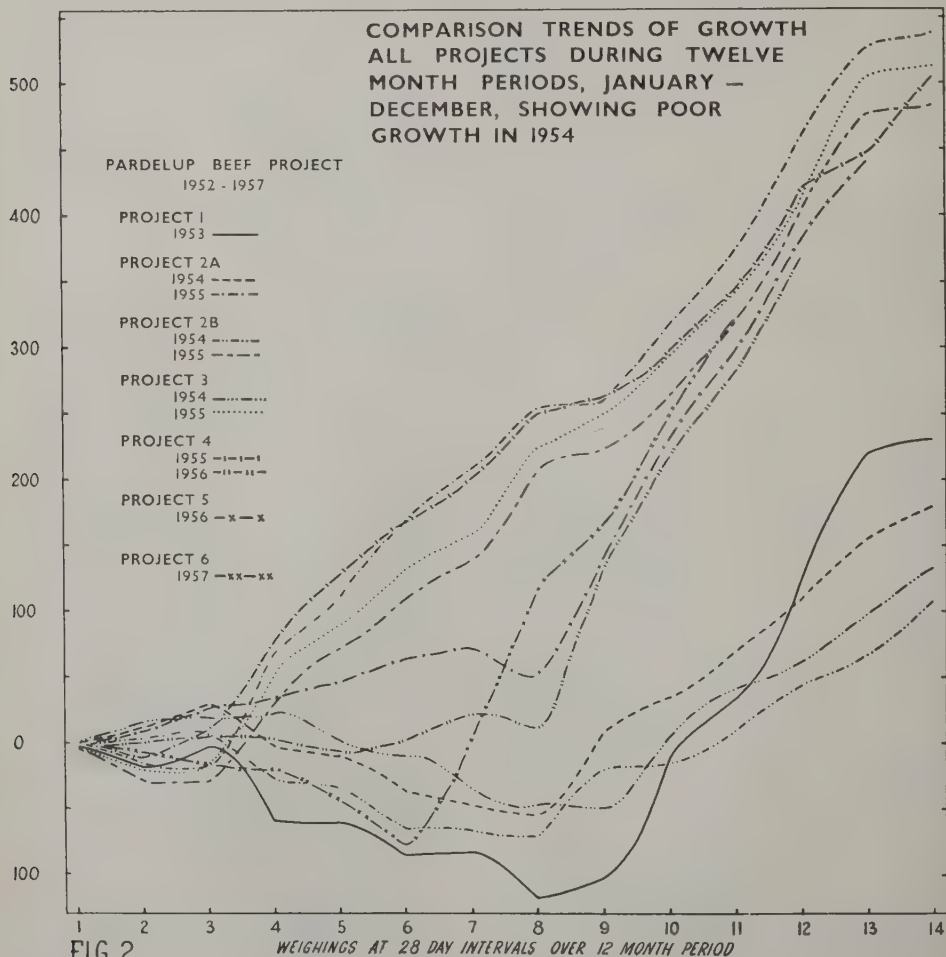


FIG. 2.

Project 4 at Wokalup, 14 Australian Illawarra Shorthorns and 18 Hereford X steers in 112 days from February 11, 1954 to June 3, 1954, put on 15 lb. (0.13 lb. per day) and 11 (0.1 lb. per day) respectively. In 112 days in the following summer, January 13 to May 5, 1955 they put on exactly the same amount, 53 lb. (0.47 lb. per day) However during a period of 224 days in the spring and early summer of 1954, from June 3, 1954 to January 13, 1955 the Australian Illawarra Shorthorns gained 342 lb. (1.52 lb. per day) while Hereford X put on 298 lb. (1.33 lb. per day.)

(d) Bush Grazing Versus Pasture. (See Fig. 4.)

The relatively poor value of bush grazing compared to that of improved pasture has been clearly demonstrated. The projects in which slowest gains have been recorded and in which the longest periods of declining weights were experienced were those in which much reliance was placed on bush feed.

Fig. 2 contains comparisons between growth trend for all projects for full calendar years. A gradual improvement

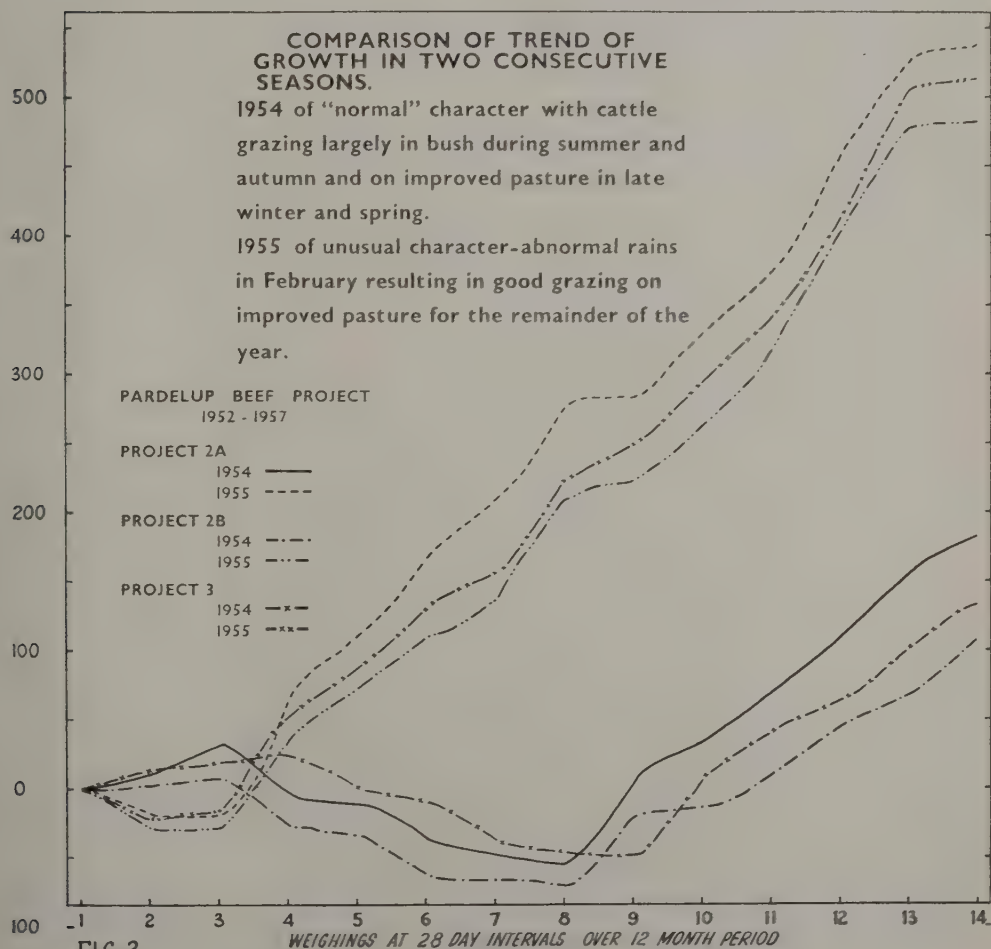


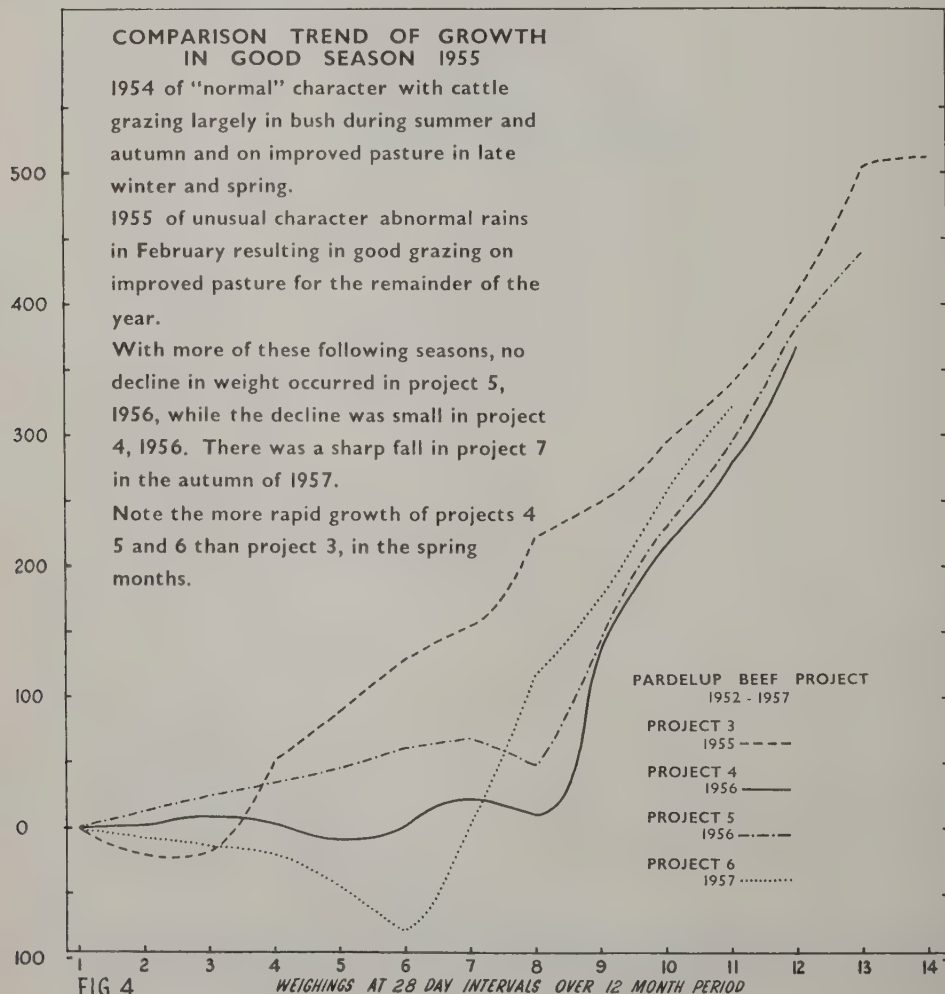
FIG. 3.

since the commencement of the investigations can be clearly seen.

The relative value of good pasture in comparison with bush feed is shown in Fig. 3. In 1955 good grazing was available throughout most of the year. Some supplementary hay feeding occurred in the winter months.

In Fig. 4 is shown the difference in trends on really good pasture (1955) and in later years when less use was made of bush feed, than in 1953 and 1954.

The years 1953 and 1954 can be considered average but as reference to the tables will show, there was an extreme use of bush paddocks for grazing. The cattle in Project 1 during the period January to December (336 days) gained 221 lb.; this included a period of static and declining weight extending from January to September. In contrast 1955 was an exceptional year inasmuch as after abnormal rain (628 points) in February, the following autumn, winter and spring falls kept



pasture growing vigorously until November, thus enabling a maximum use of good pasture and a minimum use of bush paddocks. As a result the steers in Project 3 gained 505 lb. in the same length of time. They had a shorter static period extending only from January to March. In later projects an effort was made within the range of paddocks available to give the cattle access to good pasture for longer periods, and to make minimum use of bush. The result was greatly improved growth.

Importance of Good Early Nutrition.

Although precise data was not recorded regarding birth and weaning dates, the influence of good early rearing in achieving marketing weights in a reasonable time can be clearly seen.

Most calves were born in the months of May, June and July and for the purpose of the following table June has been assumed as average.

It is known that in the early projects calves were removed from their dams while

there were in milk and on good feed. They were later turned into bush paddocks on innutritious herbage. In the later projects and in particular Project 6, weaning was delayed and took place almost naturally as feed matured. The calves therefore were gradually made to rely on grazing.

The difference in growth rates to marketable weights in the various projects is shown thus:—

Project 1—	939 lb., approximately	32 months.
"	2—1,152 lb.,	" 32 "
"	3—1,068 lb.,	" 32 ..
"	4—1,208 lb.,	" 32 ..
"	5— 957 lb.,	" 21 "
"	6— 975 lb.,	" 16 "

It will be noted that the time taken by Project 6 to reach 975 lb. was only half that required for a lesser weight 939 lb. by Project 1.

The economy of the more rapid growth enabling earlier marketing is clear, as only minimum amounts of hand feeding of hay was practised. Later weaning and better quality grazing were the determining factors.

PARDELUP

Project 1

Date	Grazing in Pasture 28 Days	Average Weight	Weight Change in 28 Days
1952		lb.	lb.
4/9/52	Bush	391	....
2/10/52	Green pasture and little scrub	390	— 1
30/10/52	Green pasture and little scrub	508	+118
26/11/52	Green pasture and little scrub	567	+ 59
24/12/52	Dry pasture and little scrub	646	+ 79
1953			
21/1/53	Dry pasture and little scrub	707	+ 61
18/2/53	Dry pasture + 7 lb. meadow hay	688	— 19
18/3/53	Bush + 7 lb. meadow hay	707	+ 19
15/4/53	Bush + 7 lb. meadow hay	650	— 57
13/5/53	Bush 2 weeks + 7 lb. meadow hay + oat stubble	648	— 2
11/6/53	Green pasture and little scrub	622	— 26
9/7/53	Green pasture and little scrub	625	+ 3
5/8/53	Bush	591	— 34
2/9/53	Bush	604	+ 13
30/9/53	Green pasture + scrub	695	+ 91
27/10/53	Bush	735	+ 40
25/11/53	Maturing pasture	831	+ 96
23/12/53	Dry pasture	928	+ 97
20/1/54	Dry pasture	939	+ 11

PARDELUP

Project 2

Date	Grazing in Pasture 28 Days	Group I		Group II	
		Average Weight	Weight Change in 28 days	Average Weight	Weight Change in 28 days
		lb.	lb.	lb.	lb.
30/9/53	Green pasture + scrub	335	....	303	....
27/10/53	Bush	363	+ 28	314	+ 11
25/11/53	Maturing pasture	416	+ 53	363	+ 49
23/12/53	Dry pasture	485	+ 69	422	+ 59
20/1/54	Dry pasture	500	+ 15	437	+ 15
17/2/54	Dry pasture	510	+ 10	439	+ 2
17/3/54	Dry pasture	532	+ 22	446	+ 7
14/4/54	Bush	497	— 35	410	— 36
12/5/54	Green pasture (short)	490	— 7	403	— 7
9/6/54	Bush	463	— 27	374	— 29
4/7/54	Bush 3 weeks, green oats 1 week	452	— 11	371	— 3
4/8/54	Bush	446	— 6	367	— 4
35 days					
8/9/54	Green pasture	508	+ 62	417	+ 50
21 days					
29/9/54	Green pasture	533	+ 25	422	+ 5
27/10/54	Bush	567	+ 34	447	+ 25
24/11/54	Bush	609	+ 42	482	+ 35
22/12/54	Bush 1 week, dry pasture + oat stubble 3 weeks	654	+ 45	544	+ 62
16/1/55	HEAVY RAIN				
19/1/55	Dry pasture + oat stubble	681	+ 27	567	+ 23
16/2/55	Germinating pasture, some scrub + 7 lb. hay, 2 weeks	662	— 19	539	— 28
16/3/55	Green pasture, some scrub + 3 lb. hay	662	....	540	+ 1
13/4/55	Green pasture + 1-2 lb. hay	747	+ 85	604	+ 64
11/5/55	Green pasture (very good)	792	+ 45	641	+ 37
8/6/55	Green pasture + 2 lb. hay	849	+ 57	678	+ 37
6/7/55	Green pasture + 3 lb. hay	889	+ 40	704	+ 26
3/8/55	Green pasture + 2 lb. hay	958	+ 69	775	+ 71
31/8/55	Green pasture 1 week, oats, vetches pasture 3 weeks	963	+ 5	792	+ 17
28/9/55	Bush	1,011	+ 48	831	+ 39
26/10/55	Green pasture	1,053	+ 42	886	+ 55
23/11/55	Maturing pasture	1,138	+ 85	968	+ 82
21/12/55	Dry pasture	1,206	+ 68	1,043	+ 75
18/1/56	Dry pasture	1,217	+ 11	1,048	+ 5

PARDELUP

Project 3

Date	Grazing in Pasture 28 Days	Average Weight	Weight Change
		lb.	lb.
23/12/53	Dry pasture	408	....
20/1/54	Dry pasture	421	+ 13
17/2/54	Dry pasture	426	+ 5
17/3/54	Dry pasture	431	+ 5
14/4/54	Bush	407	— 24
12/5/54	Green pasture (short)	398	— 9
9/6/54	Bush	368	— 30
4/7/54	Bush 3 weeks, green oats 1 week	361	— 7
4/8/54	Bush	358	— 3
35 days			

PARDELUP

Project 3—continued

Date	Grazing in Pasture 28 Days	Average Weight	Weight Change
9/9/54 21 days	Green pasture	lb. 413	lb. + 55
29/9/54	Green pasture	449	+ 36
27/10/54	Bush	471	+ 22
24/11/54	Bush	507	+ 36
22/12/54	Bush 1 week, dry pasture + oat stubble 3 weeks	540	+ 33
16/1/55	HEAVY RAIN		
19/1/55	Dry pasture + oat stubble	557	+ 17
16/2/55	Germinating pasture, some scrub + 7 lb. hay (2 weeks)	536	— 21
16/3/55	Green pasture, some scrub + 3 lb. hay	539	+ 3
13/4/55	Green pasture + 1-2 lb. hay	611	+ 72
11/5/55	Green pasture (very good)	645	+ 34
8/6/55	Green pasture + 2 lb. hay	689	+ 44
6/7/55	Green pasture + 3 lb. hay	721	+ 32
3/8/55	Green pasture + 2 lb. hay	780	+ 59
31/8/55	Green pasture 1 week, oats, vetches, pasture 3 weeks	804	+ 24
28/9/55	Bush	852	+ 48
26/10/55	Green pasture	896	+ 44
23/11/55	Maturing pasture	967	+ 71
21/12/55	Dry pasture	1,061	+ 94
18/1/56	Dry pasture	1,068	+ 7

PARDELUP

Project 4

Date	Grazing in Pasture 28 Days	Average Weight	Weight Change
27/10/54	Bush	lb. 277	lb.
24/11/54	Bush	295	+ 18
22/12/54	Bush 1 week, dry pasture + oat stubble 3 weeks	321	+ 26
16/1/55	HEAVY RAIN		
19/1/55	Dry pasture + oat stubble	335	+ 14
16/2/55	Germinating pasture, some scrub, 7 lb. hay (2 weeks)	324	— 11
16/3/55	Green pasture, some scrub, 3 lb. hay	346	+ 22
13/4/55	Green pasture + 1-2 lb. hay	413	+ 67
11/5/55	Green pasture (very good)	466	+ 53
8/6/55	Green pasture + 2 lb. hay	505	+ 39
6/7/55	Green pasture + 3 lb. hay	537	+ 32
3/8/55	Green pasture + 2 lb. hay	587	+ 50
31/8/55	Green pasture 1 week, oats, vetches, pasture 3 weeks	596	+ 9
28/9/55	Bush	630	+ 34
26/10/55	Green pasture	678	+ 48
23/11/55	Maturing pasture	757	+ 79
21/12/55	Dry pasture	831	+ 74
18/1/56	Dry pasture	841	+ 10
15/2/56	Dry pasture + 12 lb. hay	841	.....
14/3/56	Dry pasture + 12-14 lb. hay	848	+ 7
11/4/56	Dry pasture + 10-12 lb. hay	844	— 4
9/5/56	Dry pasture + 10-12 lb. hay	831	— 13
6/6/56	Dry pasture + 5-12 lb. hay	843	+ 12
4/7/56	Dry pasture + 5-12 lb. hay	864	+ 21
1/8/56	Bush	854	— 10
29/8/56	Green pasture	983	+ 129
26/9/56	Green pasture	1,058	+ 75
24/10/56	Green pasture	1,120	+ 62
21/11/56	Maturing pasture	1,208	+ 88

PARDELUP

Project 5

Date	Grazing in Pasture 28 Days	Average Weight	Weight Change
		lb.	lb.
21/12/55	Dry pasture	492	....
18/1/56	Dry pasture	512	+ 20
15/2/56	Dry pasture + 12 lb. hay	525	+ 13
14/3/56	Dry pasture + 12-14 lb. hay	537	+ 12
11/4/56	Dry pasture + 10-12 lb. hay	547	+ 10
9/5/56	Dry pasture + 10-12 lb. hay	558	+ 11
6/6/56	Dry pasture + 5-12 lb. hay	573	+ 15
4/7/56	Dry pasture + 5-12 lb. hay	581	+ 8
1/8/56	Bush	562	- 19
29/8/56	Green pasture	652	+ 90
26/9/56	Green pasture	741	+ 89
24/10/56	Green pasture	808	+ 67
21/11/56	Maturing pasture	894	+ 86
19/12/56	Dry pasture	951	+ 57
16/1/57	Dry pasture	978	+ 27
13/2/57	Dry pasture	967	- 11
13/3/57	Dry pasture + 10 lb. hay	957	- 10

PARDELUP

Project 6

Date	Grazing in Pasture 28 Days	Average Weight	Weight Change
		lb.	lb.
21/11/56	Maturing pasture	568	....
19/12/56	Dry pasture	627	+ 59
16/1/57	Dry pasture	654	+ 27
13/2/57	Dry pasture	648	- 6
13/3/57	Dry pasture + 10 lb. hay	638	- 10
10/4/57	Bush + 10 lb. hay	634	- 4
8/5/57	Bush + 10 lb. hay	611	- 23
5/6/57	Bush + 7 lb. hay	575	- 36
3/7/57	Green pasture	656	+ 81
31/7/57	Green pasture	772	+ 116
28/8/57	Green pasture	821	+ 49
25/9/57	Green pasture	905	+ 84
23/10/57	Green pasture	975	+ 70

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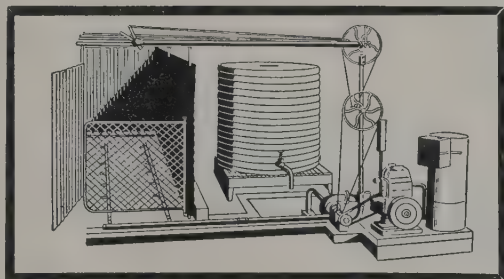
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Why not Serve a Cold Christmas Dinner?

By HELEN. M. GLOSTER

WHEN the mercury is climbing high in the thermometer, the traditional hot roast of the older, colder lands is by no means the ideal Christmas dinner for Western Australia, and each year more and more housewives are running counter to tradition and serving cold dishes.

With modern refrigeration available to most people, in the country as well as in the towns, the preparation of the Christmas dinner need no longer mean hours of hectic activity on Christmas morning but can be spread over the preceding days, leaving the housewife free to attend church with the family or to join in the entertaining of friends.

A little thought spent in preparing dainty dishes will ensure that there is no lack of festive atmosphere. Salads, savouries and sweets may be made equally attractive to the eye and to the palate.

ROAST TURKEY IN FOIL

The traditional turkey lends itself to the modern foil cookery and may be served hot with baked potatoes, vegetables, gravy and bread sauce, or cold with salads.

Ingredients.

- 1 turkey (dressed).
- 2 tablespoons dry wine.
- 2 tablespoons brandy
- 1 teaspoon thyme.
- 1 teaspoon marjoram.
- Salt.
- Pepper.
- Veal stuffing.
- Butter or lard.

Method.

1. Rub inside of cavity with salt and pepper and stuff with veal stuffing.
2. Rub outside of turkey with butter or lard.
3. Mix powdered herbs with brandy and wine, pour over turkey.
4. Wrap the turkey in foil and close tightly.
5. Bake in a hot oven (20 minutes for each pound after stuffing and wrapping).
6. Open foil and bake a further 30 minutes or until turkey is well browned.

VEAL STUFFING FOR TURKEY

Ingredients.

- 8 tablespoons soft breadcrumbs.
- 2 tablespoons butter or chopped suet.
- 1 teaspoon salt.
- $\frac{1}{4}$ teaspoon pepper.
- 1 tablespoon chopped parsley.
- 1 teaspoon grated lemon rind.
- 1 teaspoon mixed herbs.
- $\frac{1}{2}$ teaspoon mace.

Method.

Rub fat into breadcrumbs and add other ingredients.



APPETISERS

Small savouries or hors d'oeuvres served at the beginning of a meal or with drinks are rapidly gaining in popularity and lend themselves to a wide variety of attractive forms and flavours. A new and attractive form of appetiser is the "savoury dip".

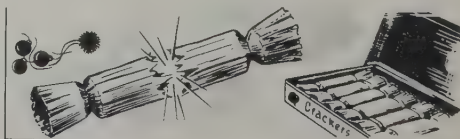
This is a savoury mixture made somewhat thicker than mayonnaise but slightly thinner than a savoury spread. A variety of different dips are served in a number of small dishes, each with its own spoon. A large dish of dry biscuits or crackers is provided and the procedure is quite informal with everybody dipping spoonfuls of the mixture on to their biscuits.

The basis of the dip can be a fairly thin white sauce, milk with whipped cream added or ordinary mayonnaise dressing. The flavourings consist of grated cheese, cottage cheese, various sauces (such as Worcester, tomato, soy sauce, chutney, etc.), finely chopped drained pickles, hard-boiled egg, fresh or tinned fish, prawns, crayfish, onions or shallots, gherkins,

olives, walnuts, chives, capers, ham, parsley, salt, pepper, cayenne pepper, mustard, paprika, curry powder, lemon juice or vinegar—experimenting with various combinations of these and other ingredients.

The best plan is to mix the required flavouring materials (finely chopped where necessary) in a bowl and then to add the liquid basis to give the required consistency. If desired, the mixture may be made to "spread" consistency and applied to the biscuits, but the "dip" idea is a popular one and offers opportunities for individual "sampling."

The mixtures should be placed in covered jars and stored in the refrigerator until required.



SOME SUGGESTED MIXTURES

Garlic Cheese Dip.

- 1 cup cottage or cream cheese.
- 1 or 2 crushed garlic cloves.
- $\frac{1}{2}$ teaspoon salt.
- 1 tablespoon chopped olives or pickles..
- Sufficient milk mixture or mayonnaise for a good dipping consistency.

Cheese and Anchovy Dip.

- 1 cup cream or cottage cheese.
- Anchovy paste.
- 2 teaspoons lemon juice.
- Dash cayenne or paprika.
- 1 teaspoon Worcester sauce.
- 1 teaspoon grated onion or finely chopped shallot.
- 1 tablespoon capers.
- Cream-milk mixture or thin white sauce.

Ham and Cheese Dip.

- 1 cup cottage cheese.
- 1 tablespoon grated horseradish.
- $\frac{1}{2}$ tablespoon grated onion.
- 1 or 2 tablespoons chopped cooked ham.
- Mayonnaise or milk mixture to make a good dipping consistency.

SAVOURY CRACKERS

1. Spread dry cracker biscuits with butter.
2. Sprinkle with salt and pepper or spread with a savoury cheese spread.
3. Heat in oven until crisp.

STUFFED CUCUMBER

1. Peel a cucumber, score the flesh with a fork.
2. Cut off one end and scoop out the seeds.
3. Stuff with any savoury cheese mixture (dip mixture but make to a stiffer consistency).
4. Chill and slice.

CELERY TRUNKS

1. Select a firm head of celery, open carefully, clean and dry.
2. Fill stalks with savoury cheese mixture, or well seasoned cream cheese.
3. Fit two stalks together to enclose the filling and tie with string.
4. Chill.
5. When firm cut in $\frac{1}{2}$ in. rings and serve on a bed of lettuce.

SUGGESTIONS FOR SALADS

Make your salads decorative by combinations of ingredients attractively arranged in patterns on large dishes. Use crisp whole lettuce leaves as a basis and include:—

- Short curled lengths of celery.
- Beetroot cut into rings, small cubes or balls.
- Sliced cucumber.
- Radishes.
- Spring onions.
- Sliced white onions.



Grated carrot.

Sliced oranges (with peel left on).

Sprigs of parsley.

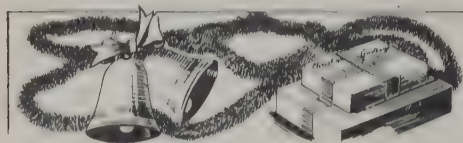
Tomatoes and hard-boiled eggs, cut into fancy shapes.

Potato salad (made separately).

Potato crisps.

Cold cooked sausages.

Slices of cold cooked ham.



SOME PARTY SWEETS

The Christmas pudding will always be the main sweet course in many households, but these intriguing party sweets have proved to be tremendously popular with the young folks.

Ice-Cream Alaska.

Ingredients—

- 1 large icecream block (hard frozen).
- 4 egg whites.
- 4 tablespoons icing sugar.
- $\frac{1}{4}$ teaspoon vanilla or other flavouring.
- 2 tablespoons brandy (optional).

Method—

1. Whisk egg whites until stiff.
2. Continue beating, gradually shaking in sifted icing sugar.
3. Add flavouring.
4. Place icecream on wooden board and cover completely with meringue.
5. Brown lightly in a very hot oven for 2 minutes.
6. Serve immediately.

An added touch would be pouring brandy on top of meringue *after* it has come to the table and setting a match to it. Serve immediately the flame dies down.

Alaska Cake.

Make as above with a layer of sponge cake between the board and the icecream. Leave an inch border all around the cake when spooning icecream on top of cake. Cover cake and icecream *completely* with meringue before baking.

Jelly Candles.

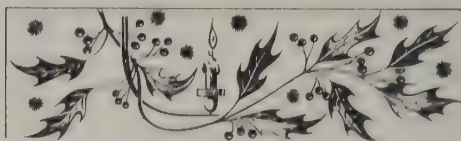
These make a decorative sweet for Christmas or party table.

Ingredients—

- 1 or more packets of red jelly.
- 1 banana for each person.
- Crystallised cherries.
- Green jelly for decoration.

Method—

1. Make jelly and set into a flat mould. Jelly should be a *firm* one.
2. Turn jelly onto a large flat dish.
3. Peel bananas, leave whole.
4. Place upright bananas into jelly, first cutting or scooping out jelly to allow banana to fit in.
5. Place a piece of crystallised cherry on top of each banana.
6. Decorate dish with chopped green jelly and cherries.
7. Serve.



Mulberry Sherbert.

Ingredients—

- 2 cups mulberry or other fruit juice.
- 1 tablespoon powdered gelatine.
- 1 cup sugar.
- $\frac{1}{4}$ cup lemon juice.
- $\frac{1}{2}$ cup cold water— $\frac{1}{2}$ pint.
- $\frac{3}{4}$ cup boiling water— $\frac{1}{2}$ pint.

Method—

1. Soften gelatine in cold water, add boiling water and stir until dissolved.
2. Add juices and sugar to gelatine mixture and stir until dissolved.
3. Pour into refrigerator tray and freeze.
4. Turn into a bowl and beat with a rotary beater until smooth.
5. Return to refrigerator and freeze until firm enough to serve.
6. Beat again until creamy just before serving.

N.B.—Tinned fruit juice or juice drained from a tin of fruit may be used instead of fresh fruit juice. Less sugar is then required.

VETERINARY SCIENCE AS A PROFESSION

TO the young person on the threshold of adult life, the choice of a career is undoubtedly the most difficult—and the most important—decision he is called upon to make. Its difficulty lies in the fact that the decision usually has to be made at a time when the person concerned seldom has adequate practical experience to guide him. Where a professional career is envisaged, the choice must be made early in life in order that suitable subjects may be studied at high school in preparation for matriculation and entry to a university.

The importance of the decision is obvious. It can lead to a lifetime of happiness and fulfilment arising from a congenial occupation, or conversely to many years of frustration and dissatisfaction. Admittedly a decision is not necessarily irrevocable, but a wrong initial choice of a career with a subsequent change to something else can result in a waste of time during the formative period when time is particularly valuable.

To young people interested in animals and stock-raising, the veterinary profession can be a fascinating and highly rewarding career with the added inducements of satisfactory financial remuneration and professional status in the community.

VETERINARY SCIENCE AND AUSTRALIAN PROSPERITY

The veterinarian makes an important contribution to Australia's prosperity, for few countries in the world are more dependent upon the animal industries. Much of our national income stems from exports of wool, meat, eggs, dairy produce, hides and skins and the task of keeping the nation's flocks and herds healthy is of paramount importance.

Only by the constant vigilance of trained veterinarians can Australia continue to remain free of such serious animal diseases as rabies, rinderpest and foot and mouth disease—to name but a few of the scourges which cost stockowners in other lands many millions of pounds every year. Modern rapid transport has greatly increased

the risks of introducing these diseases, creating a constant demand for more veterinary graduates.



Fig. 1.—Safeguarding the health of animals in zoological gardens is one of the duties which sometimes introduces variety into the life of a veterinary surgeon. Here, the chimp is taking an interest in the stethoscope

Fig. 2.—Inspecting imported dogs or animals carried as ships' pets is a task undertaken by veterinary officers engaged in quarantine duties at ports



Few, if any, of the countries of the world have a lower ratio of veterinarians per million head of animal population than Australia so there is not likely to be any risk of overcrowding in the profession for many years to come.

SCOPE FOR EMPLOYMENT

The ever-present urge to increase production per animal and per acre, and the constant quest for improvement in the quality of the various animal products has led to the establishment of numerous research programmes employing increasing numbers of veterinarians.

The Commonwealth and State Governments employ large numbers of veterinarians on the control of transmissible diseases, meat inspection, research and advisory work, quarantine inspections and on the administration of the various Acts and regulations dealing with disease control.

A growing number of commercial firms are employing veterinarians; notably drug companies engaged in the production of veterinary medicines and vaccines; firms dealing with the processing of milk and the manufacture of dairy produce; firms manufacturing stock foods and those dealing in livestock.

Private practice provides remunerative employment for a large number of veterinary graduates in town and country. Urban practice usually covers household pets such as dogs and cats with racehorses, trotters and possibly some dairy cattle in the outer suburban areas.

In country centres the veterinary practitioners are mainly found in the dairying districts, and in some States—including Western Australia—it is the Government policy to engage private practitioners to assist with tuberculin testing of cattle—a form of part-time employment which can be particularly helpful to a veterinarian engaged in building up a practice.

ASSISTANCE TO STUDENTS

Graduation in veterinary science involves a five-year course of study at a university. The first year studies may be taken at any Australian university but the subsequent four years must be spent at the Universities of Sydney or Queensland. This means that graduation is a costly undertaking, particularly for Western Australian students who have to meet travelling and living-away-from-home expenses in addition to the normal tuition fees.

Because of the need for graduates to augment the veterinary staff of the State

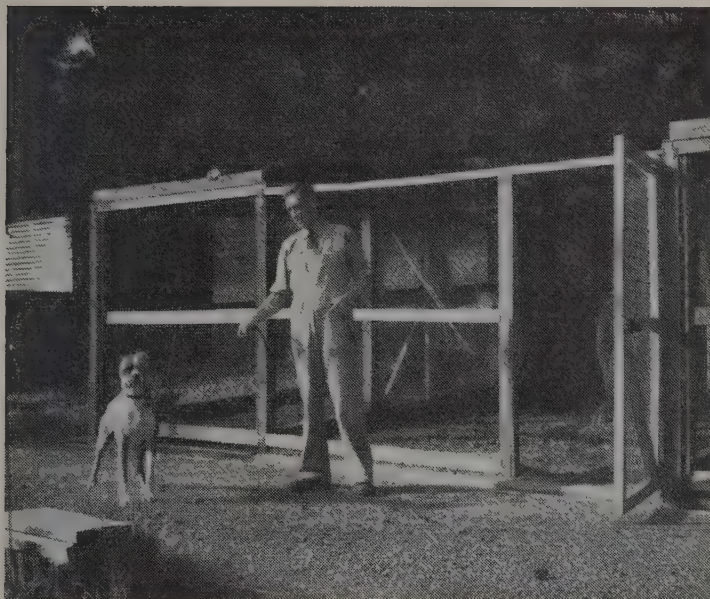


Fig. 3.—At the quarantine stations an imported animal must remain under veterinary supervision until it is given a clean bill of health

Department of Agriculture, the Western Australian Government provides veterinary science cadetships each year which considerably reduce the overhead costs.

Applicants for cadetships must have qualified for Matriculation in the Faculty of Science in the University of Western Australia, and preference will be given to applicants who possess the Leaving Certificate in English, Mathematics A and B, Physics and Chemistry.

Applicants should be between the age of 16 and 21 years. Appointments are subject to satisfactory medical and chest x-ray examinations and evidence of character.

Term of Cadetship.

The term of cadetship is five years, with the first year to be spent full-time at the University of Western Australia and the remaining four years at Brisbane or Sydney University. An extension of the term of five years may be granted in special circumstances at the discretion of the Public Service Commissioner.

Cadets are articulated to the Public Service Commissioner for the term of the cadetship and for a period of five years thereafter, but each appointment in the first instance is subject to a probationary period of 12 months.

Remuneration and Allowances.

A cadet is paid sustenance allowance at the rate of £4 10s. per week whilst in attendance during terms in the first year at the University of Western Australia. £325 p.a. is paid for succeeding years at the Brisbane or Sydney University, subject to satisfactory reports from the University authorities. Payment is made in three equal moieties in advance at the beginning of each term.

First class fares to and from Brisbane or Sydney are paid each year.

During the term and annual vacations while at the University of Western Australia—and during the annual vacations while attending the Eastern States University—students are employed by the West Australian Department of Agriculture at the following salary rates:—

Year of Cadetship.	Rates of Pay.		
	Per Week.		
	£	s.	d.
First	9	15	0
Second	11	10	0
Third	13	15	0
Fourth	15	15	0
Fifth	16	15	0

Qualifying Examination.

No cadet is deemed to have completed his cadetship until he has obtained the Degree of Bachelor of Veterinary Science at the Sydney or Queensland University.



FIG. 4.—The health of our sheep flocks is immensely important to Australia as the world's greatest producer of fine wools. Veterinary research has led to the establishment of routine disease-control measures

Permanent Appointment.

On the satisfactory completion of cadetship, a cadet, if so required, serves in the Public Service of the State for a period of five years and is appointed in the first instance as a Veterinary Surgeon, Grade 3, on a career range salary commencing at £1,315 p.a. and advancing by six annual increments to a maximum of £1,675 p.a. Subsequent advancement is by promotion to Senior Veterinary Surgeon with a salary of £2,235 with opportunities to enter higher salary ranges according to ability.

Indenture and Bond.

A prescribed Indenture and Bond (£1,000) must be executed before an applicant may be admitted as a cadet.

Applications.

Cadetships are advertised in January of each year at the time of publication of the Junior and Leaving Certificate results. Application forms are available at the office of the State Public Service Commissioner, 7th Floor, State Insurance Building, 184 St. George's Terrace, Perth, and further details concerning cadetships may be obtained from the Personnel Officer at that address.

(Note.—The gross rates of pay set out in this précis are those operating on October 26, 1959.)

DETAILS OF THE COURSE

Students who wish to enter the veterinary profession must graduate from the Faculty of Veterinary Science in the University of Sydney or Queensland.

Though there are some slight differences between the courses at Sydney and Brisbane, the subjects taken during each year of the course are:

First Year.—The students lay the foundations of their future study by taking courses in the basic sciences: chemistry, physics, botany and zoology.

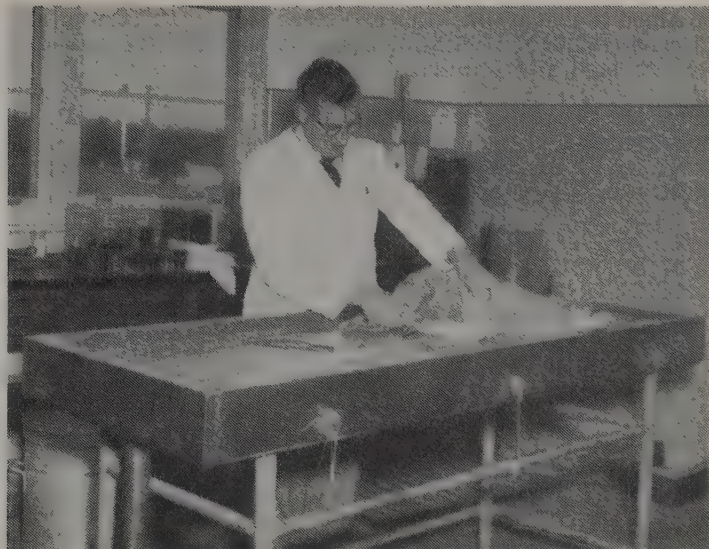
Second Year.—The main subjects are anatomy (the study of the structure of the normal animal); physiology and biochemistry (the study of the various body functions) and animal husbandry (the care and management of livestock). During this year, the student is concerned with the study of the normal animal so that later on abnormal or pathological conditions can be understood.

Third Year.—The major subjects are continued and further time is devoted to anatomy, physiology, biochemistry and animal husbandry. In this year students also commence the study of diseases (pathology) undertaking visual and microscopic examination of diseased tissues, and learning of the changes brought about by disease-producing agents.

Fourth Year.—This year is divided between a study of the courses of disease and the effects of these on the animal, together with the principles of diagnosis and treatment.

Fifth Year.—A more advanced study of several subjects, notably surgery, clinical medicine and obstetrics, is undertaken; as well as the application of animal hus-

Fig 5.—Post-mortem examinations to determine the cause of death are often a preliminary to extensive research



bandry (including nutrition and genetics) to animal production.

At the same time subjects such as meat inspection and pastoral botany are included.

Practical Work.—In all fields of applied science, the essence of learning is through personal experience, observation, and experiment. At all stages of the veterinary course, therefore, students engage largely in practical work. This includes dissection in anatomy and pathology, laboratory work in physiology, bacteriology and parasitology, and clinical work in medicine, surgery, and obstetrics.

Both Brisbane and Sydney Veterinary Schools are equipped with farms at which students are given practical training. Students are required to gain practical experience during vacation in breeding, feeding, and management of stock on approved farms and stations, thereby enabling those who have previously lived in cities and towns to learn at first hand the various phases of animal production.

Arrangements are also made for senior students to spend several weeks at veterinary research stations and with Government veterinary officers and private practitioners. Experience with veterinarians is most valuable inasmuch as the student meets at first hand the problems with

which he has to deal, and learns to apply the academic knowledge gained at the University.

After five years' study, and passing the necessary examinations, the qualification

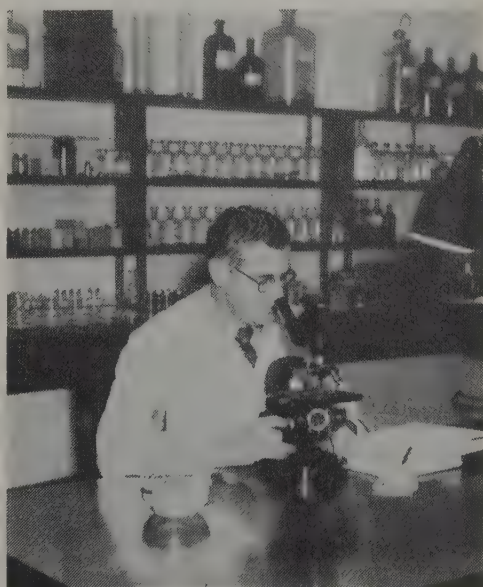


Fig. 6.—Examining animal tissues for the presence of disease

obtained is that of Bachelor of Veterinary Science (B.V.Sc.). Such a degree is necessary to hold any veterinary appointment or for registration under State Veterinary Surgeons' Boards. A Bachelor of Veterinary Science is also able to qualify in Melbourne and Brisbane for the degree of Master of Veterinary Science (M.V.Sc.)

after further study. The degree of Doctor of Veterinary Science (D.V.Sc.) is awarded to candidates who have fulfilled certain prescribed conditions, and made some notable contribution to veterinary science. Full details of these courses may be obtained on application to the Registrar of the University concerned.



CONTROL OF CATTLE LICE

Cattle markets throughout the agricultural areas are to be regularly attended by stock inspectors and firm action will be taken in the control of lice. Despite repeated warning, cattle lice are again prevalent and steps must now be taken for their eradication.

Affected animals may be required to be withdrawn from sale and owners will be required to treat their herds for the eradication of the parasites. Failure to take this action will result in the imposition of a quarantine which will remain in force until the property has been declared free of infestation.

The serious effects produced by lice do not appear to be fully appreciated. Heavy infestations can cause severe loss of condition, retarded growth of young stock, and a marked drop in the milk production of dairy herds. This will be readily understood when it is considered that affected animals are subjected to constant skin irritation and spend much of the time which would normally be devoted to feeding, in rubbing and scratching in an attempt to allay the irritation.

There are two types of lice involved—the biting lice and the sucking lice—and both cause irritation. In addition, the sucking lice are constantly withdrawing blood from the host animals and heavy infestations may result in anaemia which can be severe enough to cause death.

TREATMENT AND CONTROL

Cattle lice may be eradicated by spraying either with Dieldrin or B.H.C. (Gammexane) applied at a concentration of 0.05 per cent. These insecticides are readily available on the

market and they should be mixed and used according to the direction of the manufacturer.

When used at the recommended strength both Dieldrin and B.H.C. are safe and effective insecticides, but they have been reported on odd occasions to have produced toxic effects in young and weak animals. It is therefore safer to treat young calves and cattle in low condition with 0.5 per cent. D.D.T. A single treatment will provide a good measure of control, but two treatments separated by an interval of 14 days are essential for complete eradication. Lice eggs are seldom destroyed by spraying fluids and the second application ensures that young lice which have hatched after the first treatment are destroyed before they commence to lay.

It is essential also that all cattle on the property should be treated at the same time, since any that are left untreated, may readily re-infest the herd.

Lice populations decline in the summer, but increase and reach serious proportions in the winter, and treatment in the late autumn or early winter is necessary if this build-up is to be avoided.

Small herds may be treated with a knapsack spray or better still, with a fire-fighting unit fitted with a suitable nozzle, but care must be taken to ensure that the insecticide is thoroughly applied and each animal is completely saturated. For the treatment of large herds, power-operated sprays are a necessity. A sheep shower with the walls of the spraying enclosure strengthened and reinforced will be found very useful but an appliance such as the water-wall spray race which is specially designed for cattle and enables large numbers to be treated rapidly and efficiently is much more satisfactory.

THE AUSTRALIAN TRACTOR TESTING STATION

AN ACCOUNT OF ITS FIRST YEAR OF FULL OPERATION

SINCE September, 1957, when the Australian Tractor Testing Station was officially opened at Werribee, Victoria, by the Hon. William McMahon, Federal Minister for Primary Industry, several hundred visitors, both in conducted groups of farmers and individually, have inspected its facilities. These have included many overseas and interstate personalities in the agricultural world.

The primary purpose of the Station, the formal testing of new stock model tractors, is well known, and the value of such independent local testing is generally acknowledge. Formal tests Nos. 28, 29 and 30, covering the Zetor Super and 25, and the International AW-7, have been completed.

PRIVATE TESTS

The Annual Report of the Tractor Testing Committee for 1957-58, however, shows that the tractor trade has been quick to appreciate the value of the testing station also for private development tests.

The testing officers have undertaken, on behalf of various manufacturers, investigations on the effects of proposed changes in wheel equipment, on questions of added weight and weight distribution, and on the development of spark arresters.

On two occasions the Station was asked by local representatives of overseas engines to investigate apparent anomalies in power output, which proved to reside in the fuel injection equipment. One of these involved long correspondence with our senior colleagues, the N.I.A.E., England.

The power output of a pump-drive-shaft on a special vehicle, is being investigated; discussions are going on for a series of tests on diesel fuels for transport vehicles, and for a test on a specially equipped crawler tractor for a large government department.

CRAWLER TEST TRACK

A test track for crawler tractors has been marked out on a site adjacent to the Station. It is expected that this new

facility will shortly be used for formal tests on a number of crawler models now marketed in Australia.

SPARK ARRESTERS

Much interest was shown in the draft specification for testing spark arresters published by the Committee in August 1957. Numerous stock models and prototype arresters have been submitted to this test, based on the S.A.E. code; reports on stock models, though not yet published, are nevertheless available and open for inspection. The Station officers were gratified to find the companies ready to accept suggestions for modifications in order to secure compliance with the S.A.E. requirements.

At present the test does not concern itself with exhaust gas cooling or flame proofing; these aspects are of concern to aviation authorities, among others, and a request that this feature be investigated is at present under consideration.

RESEARCH

As provided in its charter, the Tractor Testing Station has also functioned as a research centre for Agricultural Engineering for the University of Melbourne. For example, the University hopes to undertake, in 1959, the measurement of the moments of inertia of a tractor. These physical properties affect the dynamic angles of tilt and tip-up at which tractors may be safely worked. It is possible that this work could lead to the development of a routine test procedure that would enable some objective assessment of the dynamic stability of particular tractors.

At present the station facilities are being used by Assistant Professor Beach of the University of Saskatchewan, Canada, for a research project on engine exhausts that he is undertaking as part of a year's study in Melbourne.

PUBLICATIONS

Test reports on tractors are printed in two editions:—

1. The full technical report, which is widely circulated on the Station's mailing list both here and overseas, as well as by the applicant company. 2. A shorter and simpler farmer's edition which is published in some of the State Journals of Agriculture, and is widely available in reprint form. The full reports are also published in the monthly, "Power Farming in Australia and New Zealand," and in its Annual.

During the year, apart from test reports on tractors and spark arresters, and the Draft Test Code for Spark Arresters, the Station officers have published the following papers:—

- (a) "Field Tests on 14 x 30 Tractor Tyres" by Vasey and Naylor in the Journal of Agricultural Engineering Research (U.K.) January, September 1958; this appeared by permission of Dunlop Rubber Australia Pty. Ltd., for whom the work was done.
- (b) "Hydraulic Torque Converters in Tractors" by Vasey, in the Proceedings of the Institution of Mechanical Engineers, London October, 1958.

INQUIRIES

Upwards of a hundred inquiries in a year come to the Station from farmers interested in the performance of their tractors or in prospective purchases. Since many of the tractors in question have not been tested in Australia, the replies are necessarily based on overseas reports; as the replies point out, these overseas reports may not apply to the tractors as sold in Australia.

FUTURE WORK

Apart from the formal tests on stock models—tractors, engines and spark arresters—the Station expects a continued flow of enquiries for tests of an experimental, checking or developmental nature from both industry and government departments. The testing officers are considering also, how to modify the test procedures, so as to cope with farm vehicles of high power, light weight, and four wheel drive—several models of which have recently appeared.

TRACTOR TESTING COMMITTEE

- C. G. Mathams.—Department of Primary Industry (Chairman).
- B. F. McKeoh.—Department of Agriculture, Victoria.
- G. H. Vasey.—University of Melbourne.
Secretary, W. G. SMITH,
Dept. of Primary Industry,
301 Flinders Lane, Melbourne.

Staff (University of Melbourne, Carlton N.3).

- G. H. Vasey (Officer-in-Charge).
- W. F. Baillie (Testing Officer).
- N. Walkadine (Technical Assistant).

DAIRY HYGIENE DISAPPOINTS

Many dairy farmers are satisfied with too low a standard of cleanliness in their dairy work. Dilapidated buildings, faulty doors, inadequate drainage, deteriorated rubber ware on milking machines, insufficient water supplies and absence of suitable water-heating arrangements are still far too common.

These points were emphasised by the Superintendent of Dairying (Mr. M. Cullity) recently in a report upon dairy inspection work.

Routine inspections of farm dairies have been carried out by Dairy Instructors of the Department of Agriculture, and these officers have been ordered to ensure that premises and equipment are maintained in clean condition. Where necessary they are authorised to issue written instructions requiring improvements to be made within a stated time.

Such improvements are ordered with a view to keeping the cost to the farmer as low as possible and in many cases the farmer would be well advised to spend more than is required to achieve the minimum standards.

The Importance

of Long Productive Life in Dairy Cows

By L. C. SNOOK, D.Sc., Animal Nutrition Officer.

THE dairy industry suffers serious economic loss because the productive life of most dairy cows is much shorter than it should be. In Western Australia it would be difficult to find a commercial herd in which the average cow has more than four lactations. This is consistent with the experience in most dairying countries where it is accepted that the shed life ranges between three and four lactations. With good quality stock the milk yield generally shows a steady increase up to the sixth lactation. This means that the majority of dairy cows never reach the peak of their productive potential.

Of more seriousness is the fact that, in general, it is the best producers which are lost relatively early in life. Obviously it is important to find out how the number of lactations per cow can be increased.

At the Bramley Research Station a number of cows which first calved in 1951 have been retained to see just how long profitable production will continue. These cows, which were purchased for use in the first trials carried out at the Research Station, are ordinary A.I.S. grades. Those which have been retained are now in their ninth lactation. In the industry these cows would be considered quite old.

No. 33 is one of these. This cow was the most productive of the 12 cows in the original control group. During the three years in which no phosphatic supplement was fed this cow averaged 725 gallons of milk (3.5 per cent. butterfat) containing 252 lb. of butterfat. A phosphatic supplement was supplied during the next three lactations during which the average milk yield increased to 936 gallons (3.6 per cent. butterfat) containing 339 lb. of butterfat. A further 950 gallons of milk was obtained in the seventh lactation. This cow has never given any trouble and on May 5 calved down as usual. In the third month of her ninth lactation, she is giving four gallons of milk daily. This cow has received a phosphatic supplement over the last six years and appears set for further years of production.

No. 45 did rather poorly as a young cow while in the control group. In fact, had the cow not been an experimental animal it would have been culled, as the average production over three lactations was only 465 gallons of milk and 182 lb. of butterfat. But when this cow was transferred to the phosphate group production jumped to 310 lb. of butterfat in the first season and to 1,007 gallons of milk and 428 lb. of butterfat in the second lactation on phosphate. In 1957-58 this cow produced a further 419 lb. of butterfat. Last season, No. 45 was somewhat slow in coming into oestrus and as a result this year did not calve until July 1. There is every promise, however,



Fig. 1.—Cow No. 33 photographed in her fourth lactation

that another good lactation will result: during recent weeks the daily milk yield has ranged between 50 and 57 lb., with a peak "test" of 2.7 lb. of butterfat. Production figures of this order indicate all too clearly that the short shed life characteristic of the modern cow is a major source of economic waste.

Another interesting old cow, No. 3, was purchased with the property in 1950 while in its second or third lactation. This animal was used to see if a continued intake of 4 oz. of ground rock phosphate every day would produce any harmful effects. After eight years on the supplement this cow was pensioned off and still remains in apparent good health despite her age. During the trial period No. 3 averaged 953 gallons of milk and 405 lb. of butterfat in each of eight lactations. The butterfat at 4s. per pound has been worth £567 so this animal has been a very profitable purchase. It should be apparent to

everyone that with each additional lactation period the net profit from a good cow is markedly increased.

It is important to find out how to obtain long productive life from first class cows. To do this the animals must conceive regularly, remain free from calving troubles and metabolic disturbances, and escape the ravages of mastitis. Good breeding to ensure well-attached udders is also essential—some of the best cows which were acquired by the Research Station have had to be culled because of pendulous udders.

At Bramley the cows which have received phosphatic supplements have an excellent record for regular conception and there has been a remarkable freedom from those bovine upsets which recur all too frequently on many commercial properties. It seems reasonable to assume that the use of the phosphatic supplement has been of value in achieving this result. For example, there were seven cows which had produced over 300 lb. of butterfat on one lactation, among the cows which received no phosphatic supplement from the third to the sixth lactation. Of these seven cows only one remained to calve down in the seventh lactation. In contrast every one of the six high producers receiving a phosphate supplement during the same period conceived normally for the seventh lactation.

These comments have been prepared mainly to make the dairy farmer realise the greatly increased profits which result from long productive life in the milking herd. The few examples quoted from Bramley show that good cows can be kept in regular production for at least nine lactations. To achieve this long shed life good pastures and a careful milking routine is essential—and the regular use of phosphatic supplements.



Fig. 2.—Cow No. 3 which averaged 953 gallons of milk and 405 lb. butterfat in each of eight lactations

FARMERS

This is **YOUR** Journal, and it has been written, edited and presented in a sincere endeavour to give you helpful information in an interesting manner.

We would like to have your views on the Journal—to know whether you like it or whether you don't. Drop a line to the editor and tell him the features you like and don't like in this issue—or the features you hope to see in future issues.



Sheep grazing on an area of mown pasture on the Moora property of Mr. R. B. Lukin

Sheep Grazing Experiment With Mown and Unmown Pasture, Chapman Research Station, 1958-1959

By G. L. THROSSELL, Senior Agriculture Adviser, Geraldton, and
S. D. T. BYRNE, Manager, Chapman Research Station

INVESTIGATIONS carried out several years ago at the Avondale, Chapman and Wongan Hills Research Station showed that increased wool yields and reduced liveweight losses could be obtained by grazing sheep on pasture which had been mown at the hay stage and left in the paddock instead of allowing it to mature and dry off normally.

In order to obtain further information on this aspect of pasture and sheep husbandry in the northern agricultural areas, an experiment was carried out at the Chapman Research Station during last summer.

A uniform area of eight acres of subterranean clover and grass pasture was selected, half of which was mown on September 25 at the correct hay stage and left to lie as cut, while the remaining four acres was allowed to mature in the normal way. The yield of cured hay was assessed at 33 cwt. per acre.

The approximate botanical composition of the pasture was assessed as subterranean clover (Dwalganup) 60 per cent.; Wimmera ryegrass 30 per cent.; capeweed 5 per cent., other volunteer species 5 per cent.

By November 17, the unmown pasture had matured and dried off. Between this time and the time of mowing, 151 points of rain had fallen in 12 days. On the mown section this resulted in an abnormal amount of regrowth, principally Wimmera ryegrass, which was estimated at 4 cwt. per acre. It was considered that none of these falls would appreciably affect the quality of the hay. The heaviest fall 68 points, was recorded only three days after mowing.

Subsequent rainfall to the end of the grazing period amounted to 127 points which also occurred in light falls on eight days, except for 85 points registered on December 18. This fell in a downpour lasting 45 minutes and may have affected the quality of the hay but had no apparent effect on its palatability.

The two paddocks were stocked on December 8, 1958, with lightweight two-tooth Merino wethers, the sheep being selected by alternate drafting. This stocking rate represented a rate of one wether per 2.75 cwt. of cut hay, plus regrowth, on the mown sections. Thus the total number of sheep on each of the four-acre sections was 55 or 13.75 sheep per acre.

The sheep were weighed at intervals during the 13 weeks of the duration of the trial, which terminated March 9, 1959. At this stage all the pasture had been completely cleaned up in the mown section, and because of this the sheep had commenced to lose weight. In the unmown section approximately 1 cwt. of unpalatable dry matter per acre remained.

After the termination of the trial the sheep from both sections were run together and were shorn on April 16, 1959, and the individual fleeces weighed.

In view of the rate of stocking the sheep held their weights very well. The relative higher average weight of the mown group at the end of the grazing period was 5.6 lb. (significant at 0.1 per cent.). These sheep also produced .4 lb. more wool per head which was equivalent to 5.5 lb. per acre (significant at 5 per cent.).

This experiment confirms the result of the experiment conducted in 1955-56 at this station. The differences in wool production are in favour of mowing pastures,

even at the present wool values. In view of the fact that there is often an improvement in the following year in this area in the composition of pasture in paddocks which have been mown, this aspect of pasture management can be continued with confidence, as an additional supplement to the usual basic reserves of hay and grain.

The results of the weighings were as follows:—

CHAPMAN RESEARCH STATION—SUMMER GRAZING
EXPERIMENT, 1958-59
Body Weight Trends and Wool Yields

Plot Treatment	Average weight of sheep at		Average gain or loss in weight	Difference due to mowing	Average wool yield per sheep	Increase in wool yield due to mowing	
	8/12/58	9/3/59				Per sheep	Per acre
Mown and left	1b. 91.7	1b. 95.6	+3.9	+5.6	7.5	.4	5.5
Not mown—matured normally	93.6	91.9	—1.7	....	7.1	....	....

REFERENCE

"More Efficient Use of Pasture for Summer Grazing" by N. Davenport. *Journal of Agriculture of W.A.* Vol. 6. No. 4 July-August 1957. Reprinted as Bulletin No. 2453.

EMU-PROOF FENCES

Considerable interest is being taken in the two emu barrier fences which had been constructed by the Agriculture Protection Board recently, said the Minister for Agriculture (Mr. C. D. Nalder) recently. The design and construction has received favourable comment and already a big movement of emus to the north-east of Geraldton has been stopped.

One fence just over 120 miles long has been erected to the north-east of Dalwallinu between the No. 1 and No. 2 Vermin fences. The fence, which runs roughly east and west, crosses Lakes Moore and Monger, and is designed to prevent the large-scale movement of emus which had occurred so often in the past from the north into the north-eastern agricultural areas in the vicinity of Kalannie to Bonnie Rock.

Work on this fence was commenced in March, 1957, but owing to difficulties in construction it was not finished until April this year.

The other fence near Ajana to the north of Geraldton is approximately 12 miles long and is a spur fence jutting out in a northerly direc-

tion from the No. 3 Vermin Fence. Its primary purpose is to divert the mass movement of emus along the north side of the vermin fence from a number of farms outside the main fenced area. The farmers receiving direct protection will pay half the costs of this fence. Although the brunt of the movements will be taken by the Protection Board fence, the farmers have agreed to ring the area by strengthening their outer boundary fences. The Ajana fence was commenced in July, 1958, and completed by January, 1959.

Both fences are 4 ft. 6 in. high and consist of rabbit netting placed above the ground to a height of 3 ft. 6 in. Above the netting is a plain wire, a barbed wire and then another plain wire, all 4 in. apart. The wires are connected together and to the netting by three evenly spaced spiral wire droppers between posts.

Gates and motor traffic passes have been installed where necessary.

Posts are 15 ft. apart and are of native pine which has been found to have a high resistance to white ants and dry rot when used in localities near where the trees were growing.

Observations . . .

on the

Breeding Performance of Merinos at *ABYDOS STATION*

By H. SUIJDENDORP, B.Sc.(Agric.), Regional Adviser, North-West Branch

ABYDOS STATION is situated in the spinifex country some 90 miles inland from Port Hedland and is one of several stations in the area which were abandoned about 15 years ago, following upon a marked decline in their sheep-carrying capacity extending over a number of years. Abydos and the adjoining station, Woodstock, were purchased by the West Australian Government in 1946 as a site for research into local pastoral problems.

Considerable work on encouraging the regeneration of suitable native vegetation by "deferred grazing" has been carried out at Abydos, and some portions of the property are now capable of supporting one sheep to five acres.

During the past two years, these areas have been used to collect further information on the breeding performances of Merino sheep under local conditions.

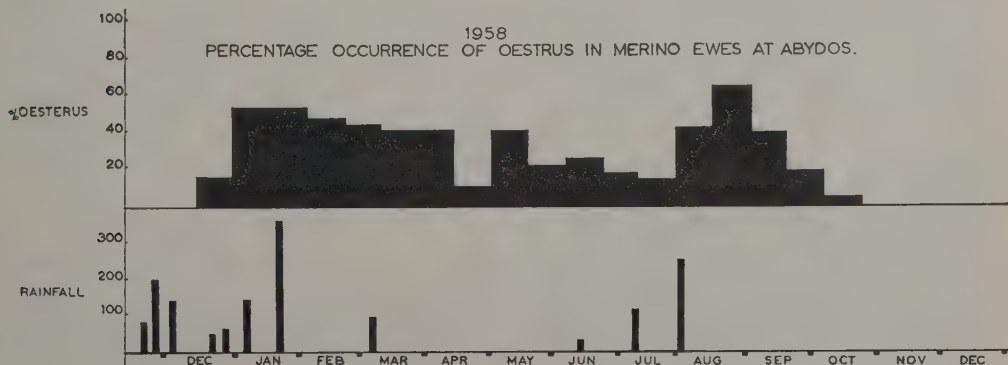
OCCURRENCE OF OESTRUS

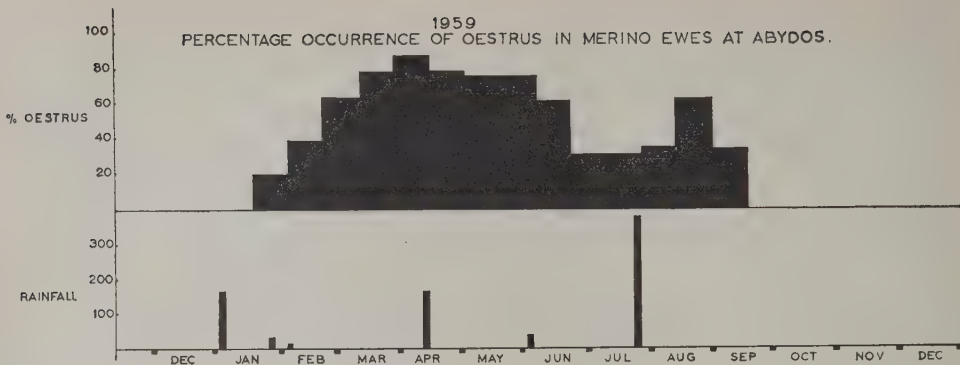
Observation of the oestrus or "heat periods" of ewes carried out in 1958 and 1959 gave the results shown on the accompanying diagrams, which also show the rainfall patterns in the area for those two seasons.

Both years were unusual in that good rains were recorded in the July periods following prolonged dry spells. These rains resulted in a good flush of green feed with a corresponding high level of oestrus in August.

Earlier in the year the high level of oestrus activity did not occur until April although in the 1957-58 season, good rains fell early in December.

These patterns are not markedly different from those observed elsewhere in Australia. It is interesting to note that the level of activity was higher and more prolonged in the light rainfall year of 1959. This again appears to be a common pattern of breeding behaviour in these areas—a light rainfall year appears to lead to





greater breeding activity but this is offset by a lower rate of lamb survival.

LAMBING OBSERVATIONS

Apropos of this, of 50 lambs dropped in June, 1958, under very dry conditions 20 died within 24 hours of birth as the ewes had little or no udder development. The remaining 30 survived to maturity but their weight gains were very low, averaging about $\frac{1}{4}$ lb. per day.

In 1959, 40 ewes were put with the rams on February 25. Conditions were very dry during the mating period as only two inches of rain had fallen during the summer.

Maximum temperatures varied from 108° to 112° F. with minima of 77° 80°.

Locally-bred rams were used.

Mating.

Observations showed that 28 of the ewes were served once, nine were served twice, one failed to conceive after four services, one did not come into oestrus and one old ewe died on the mating paddocks.

Lambing.

Three ewes died before lambing, probably from pregnancy toxæmia, which brought the effective lambing numbers to 34 ewes all of which gave birth to lambs.

Four lambs were dropped during the rain and these were very light, weighing under 5 lb. All four, together with another light-weight lamb, failed to survive. The remaining 29 lambs, representing 72 per

cent. of ewes mated, were weaned successfully.

Their birth weights varied from 7 to 9 lb. apart from one exceptionally heavy lamb which weighed 11 lb. Weight gains were good for native pasture and averaged $\frac{1}{2}$ lb. per day for the first 24 days with no marked differences between individuals.

It must be stressed however, that in most years the survival rate would have been very much lower. In general, no rains are expected to fall as late as July-August and the ewes would normally be on dry innutritious feed at a time when they require extra nourishment for lambing and milk production.

COMMENT

To ensure adequate nutrition at the most critical period—during the later pregnancy period and during early lactation—an April-May lamb-drop would be most likely to produce satisfactory results. This however would involve mating during early December when the ewes' oestrus activity appears to be very low.

As an alternative, a mating in March with a small quantity of supplementary feeding, prior to and during lambing, might be worth considering. Both possibilities will be investigated this summer.

ACKNOWLEDGMENT

Sheep used in these experiments were made available by Mundabullangana and Warralong Stations. All observations were made by Mr. R. H. Collett, Field Assistant.

LIST OF DEPARTMENTAL PUBLICATIONS

The bulletins named in the following list are mainly reprints of articles which have appeared in "The Journal of Agriculture" and the date of the original publication has been appended to facilitate reference to bound volumes of the Journal. Except where a price is expressly stated, these bulletins may be obtained free of charge either by applying at the counter of the Department of Agriculture or by writing to the Officer-in-Charge of Publications, Department of Agriculture, Perth. If ordering by letter please quote the serial numbers of the bulletins, not the titles. Not more than ten bulletins can be supplied in response to each application.

APICULTURE

- 2052 Diseases of Bees—May, 1953.
- 2342 Raising Queen Bees—July, 1952.
- 2347 Beekeeping in Western Australia—May, 1956.
- 2348 Beekeeper's Carry-all—May, 1956.
- 2410 Ant-proofing the Apiary—January, 1957.
- 2528 Wax Moth—An Apilary Problem—Mar., 1958.
- 2602 Control of Swarming—May, 1952.

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- 1095 Strain 19 for the Control of Brucellosis—Mar., 1952.
- 2000 Actinomycosis and Actinobacillosis—May, 1952.
- 2000 Vibriosis Recorded in South-West Herds—May, 1952.
- 2065 Identical Twins—May, 1953.
- 2071 Milk Fever in the Dairy Cow—Sept., 1941.
- 2072 Tetanus in Farm Animals—Sept., 1947.
- 2097 The Spaying of Cattle—Sept., 1953.
- 2108 Diseases of Goats—Jan., 1954.
- 2121 Infectious Keratitis (Pinkeye) in Cattle—Jan., 1954.
- 2137 Breeding Tables for Farm Animals—Mar., 1954.
- 2181 Genetics and Animal Breeding—Mar., 1951.
- 2211 A Crush for the Tuberculin Testing of Cattle—Nov., 1954.
- 2213 Acetonaemia in Dairy Cows—Nov., 1954.
- 2217 Foot Rot (Foul Foot) of Dairy Cattle—Nov., 1954.
- 2243 Phosphorus Supplements for Dairy Cows—Mar., 1955.
- 2255 Preparation and Handling of Dairy Cattle for Shows—May, 1955.
- 2277 Brucellosis of Cattle—July, 1955.
- 2301 Rules of the W.A. Official Pure Bred Dairy Cattle Production Recording Scheme—Nov., 1955.
- 2311 Lice on Cattle—Jan., 1956, July, 1954.
- 2337 Cattle Corner—Gosy Calves—Oats for Early Grazing—Calf Marking—Mar., 1956.
- 2344 Internal Parasites of Cattle—Sept., 1952.
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- 2375 Leptospirosis (Redwater) in Calves—Sept., 1956.
- 2398 Tuberculosis—Nov., 1956.
- 2404 Warts on Cattle—Nov., 1956.
- 2407 Stock Disease Control by Correspondence—Nov., 1956.
- 2415 Summer Feeding of Weaner Beef Steers—Jan., 1957.
- 2417 Bluetongue—Its Relationship to Cattle Importations from the U.S.A.—Jan., 1957.
- 2427 The Dehorning of Cattle—Mar., 1957.
- 2428 Cattle Corner—Mar., 1957.
- 2436 Feeds and Feeding.
- 2452 Cattle-Working Yards—Compact and Effective Layout—May, 1952.
- 2459 Vitamen A Supplements for Sheep and Cattle—July, 1957.
- 2465 Minerals for Livestock—July, 1957.
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- 2554 Late Summer v. Autumn Calving for Beef Production—July, 1958.
- 2567 Milk Fever (Parturient Hypocalcaemia) in the Dairy Cow—Sept., 1958.
- 2585 Twin Calves and Infertility—How Freemartins occur—Nov., 1958.
- 2611 Mineral Supplements for Stock in Pastoral Areas Jan., 1959.
- 2617 Winter Dysentery—Mar., 1959.
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- 2625 A Simple Method of Throwing Cattle—Mar., 1959.
- 2627 Hexoestrol Implants with Yearling Steers—Mar., 1959.
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- 1016 Better Dairying Competition 1949-50—Sept., 1950.
- 1036 Dairy Herd Improvement Scheme—Nov., 1949.
- 1059 Dairy Herd Improvement Scheme, 1950-51—Sept., 1951.
- 2017 Better Dairying Competition 1951-52—Sept., 1952.
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- 2077 We Need More Silage—Part 1—July, 1953.
- 2088 We Need More Silage—Part 2—Sept., 1953.
- 2101 We Need More Silage—Part 3—Nov., 1953.
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- 2282 Sorghums for Grain and Fodder in the South-West—July, 1955.
- 2376 Modern Silage Making—Sept., 1956.

- 2405 Electric Fences on Dairy Farms—Nov., 1956.
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- 953 Yield and Flour Strength of Wheat—Mar., 1949.
- 1048 A Calendar of Farming Operations—July, 1952.
- 2020 Pedigree Seed of Wheat, Oats and Barley—Dec., 1952.
- 2142 The Basic Principles of Wheat Marketing (Price 2s.).
- 2174 Oats and Barley Varieties in W.A.—July, 1954.
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- 2529 The Use of Copper and Zinc in the Cereal-Growing Districts of W.A.—Mar., 1958.
- 2533 Demonstrations Show the Value of Fodder Crops—Mar., 1958.
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- 2186 Farm Butchering—Slaughtering, Skinning and Dressing a Sheep—Sept., 1954.
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- 1007 Apple Leafhopper. Its control at Donnybrook—June, 1950.
- 1025 Pea Weevil—Sept., 1943.
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- 2001 Snails and Slugs—June, 1944.
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- 2188 Potato Moth—Sept., 1954.
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- 2300 New Hosts Records for the Mediterranean Fruit Fly in W.A.—Nov., 1955.
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- 2331 The Red-Legged Earth Mite and Lucerne Flea—Mar., 1956.
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- 2431 New Insecticides for House-Fly Control—Mar., 1957.
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- 2393 Roaded Catchments for Farm Water Supplies—Nov., 1956.
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HORSE LOSSES IN WEST KIMBERLEY

Reports of deaths of horses occurring over a long period on West Kimberley stations led to some preliminary investigations in June by officers of the Animal Division of the Department of Agriculture, but few animals were seen showing symptoms and it was difficult to obtain reliable case-histories.

The Chief Veterinary Surgeon (Mr. C. R. Toop) said that a further investigation was planned to commence at the end of the wet season and a botanical survey would be made of the affected areas.

The losses had occurred on several properties located on the south side of the Fitzroy River between Fitzroy Crossing and Luluigui. Although it was believed that "Kimberley Horse Disease" was responsible for a proportion of the deaths, the evidence suggested that other factors may have been responsible.

A co-operative investigation recently carried out by the C.S.I.R.O., West Australian Department of Agriculture and the Northern Territory Administration indicated that Kimberley Horse Disease resulted from the ingestion of the wedge-leaved rattlepod (*Crotalaria retusa*), a plant which grows mainly on the river frontage country. Mortalities had occurred among horses which had not been running on the frontage country, and among others which had not had access to *Crotalaria retusa* for some considerable time. These facts, together with reports of symptoms differing from those of Kimberley Horse Disease appeared to warrant further investigation.

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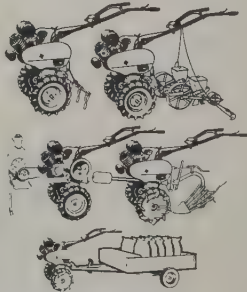
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A Century of *RABBITS*



By A. R. TOMLINSON,
Chief Vermin Control Officer

THE year 1959 cannot be allowed to pass without mention of the centenary of an event which probably has affected Australia's primary production more than any other single factor. A century ago, the rabbits which were eventually to spread over the whole continent, arrived in Australia. The almost incredible cost of this introduction to Australia—it must amount to hundreds or even thousands of millions of pounds—and the stranglehold they have exercised over the rural industry should mark the day they were landed as one of the blackest in our history. Although it is not a centenary to be celebrated it is one that none of us can afford to forget.

Admittedly, rabbits were brought to Australia before 1859. There is a record of some arriving in 1788, and it is well known that others were liberated on islands around the coast including some off Western Australia. However, they remained localised and it is now generally accepted that the rabbits which did spread originated from a small shipment of the wild type brought on the clipper "Lightning" in 1859. They were released in Barwon Park, the property of Thomas Austin, near Geelong, Victoria, and within three years had reached pest proportions locally. Twenty years later, rabbits had crossed the South Australian and New South Wales borders. By May, 1886 and travelling at 70 miles a year, they were in Queensland.

The westerly branch which had reached South Australia by 1880 had crossed to the other side of the State in 12 years. They were in Western Australia two years later and had travelled 900 miles to Geraldton by 1907, or 25 years after appearing in Western Australia. In actual fact the Barwon Park rabbits had spread to the north and across Australia in less than 50 years.

The spread was not spectacular with a horde of rabbits advancing like a tidal wave. First one or two rabbits would appear, and often property owners welcomed them as curiosities. Then suddenly the district would be over-run with them as if a major invasion had occurred. We

know now that within the rabbit populations are some which colonise an area and are permanent residents, while there are others which are footloose and will move on. At the incredible rate rabbits breed, the small advance guard was all that was necessary to establish and to expand into the big colonies and, in fact, they brought their own reinforcements with them. From the age of four months does are capable of producing a litter of about five kittens in a month, and this will continue as long as conditions are favourable, possibly eight or more times in a year.

The initial invasion of Western Australia appears to have moved both north and south of the Nullarbor Plains and swept up into the North-West pastoral areas as well as into the agricultural districts. The northerly tide receded but there are still pockets of rabbits left even along the Canning Stock Route. In favourable seasons these rapidly multiply and then decline as dry conditions take over.

Although some rabbits had already moved westward the rabbit-proof fences which were erected early in his century slowed down the general advance in Western Australia. Despite this the rabbits multiplied until they had overrun the agricultural areas and reached plague proportions.

It was estimated several years ago that rabbits were costing Australia £400,000,000 a year in sheep and cattle which could

have been run if rabbits had not already deprived them of pasture. When to this is added the cost of crops taken, soil erosion, control work and fencing the figure would reach astronomical proportions.

The farmers in Western Australia have paid a great deal for this pest also. Tests carried out indicated that rabbits were depriving the agricultural areas of at least 50 per cent. of their pastures and even up to 85 per cent. This means that for every hour's work a farmer put in, every pound he spent on machinery, fertilisers, seeds and similar items, at least one half was for feeding rabbits.

There is hardly any need for me to refer to the seeming miracle a few years ago when myxomatosis, assisted by "1080" poisoning drives wiped out millions of rabbits throughout this State. Today, a hundred years after their forefathers were introduced, we are again witnessing the remarkable adaptability, tenacity and

resilience of this small animal. Despite the decimation resulting from possibly the most potent disease ever to attack any animal population, the onslaughts of the most effective poison yet produced, together with other organised attacks there can be no question that they are at least holding their own at present, and in many places they have actually increased again. In 1859 there were only a few rabbits at Barwon Park and they spread to give Western Australia—over 2,000 miles away—a rabbit plague. Today thousands of colonies as big as or even bigger than the original Barwon Park group are already in Western Australia. They are well distributed over the countryside and within easy distance of every farm. They certainly do not need to travel 2,000 miles to become a plague again in Western Australia. They only need to travel a few hundred yards at the most, so it behoves every land-owner to get busy—and to keep busy—on rabbit destruction.

PESTS PLAGUE PASTORALISTS

Apart from the well-known vermin such as dingoes and rabbits, primary producers and vermin control authorities were troubled by many other animal pests including domestic animals which had gone wild such as camels, donkeys, horses, pigs, goats and even wild cattle.

The Minister for Agriculture (Mr. C. D. Nalder) said that with the exception of wild cattle, all of these have been declared vermin in various local authority districts—mainly in the pastoral areas—at the request of the road or vermin boards concerned.

While some of the authorities still relied on the bonus system others were realising that the most effective way of dealing with pests of this nature was organised destruction work and drives.

In some areas the authorities had appointed special rangers or hunters to destroy wild horses and donkeys with very good results. In others, pastoralists, local authorities and Agriculture Protection Board officers had combined in shooting drives against the donkeys.

Doggers were constantly shooting wild camels for the humps which are excellent for making wild dog baits.

The main damage caused by these pests was to pastures and other vegetation but they also competed with stock for available water supply as well as damaging water installations, fences, etc.

Worms in CATTLE

By J. SHILKIN, B.V.Sc.—Asst. Chief Veterinary Surgeon

(From an A.B.C. Country Hour Broadcast.)

FOR many years, work on the internal parasites of sheep has been carried out in Australia, and the knowledge gained has placed this country well to the fore on this work. These are continuing investigations because of the problems involved but scientists in Australia have amassed a tremendous amount of knowledge in this field.

On the other hand the problem of internal parasitic infestation in cattle which has been, and still is, the cause of serious loss, particularly in young cattle, has not been given the same attention and it is only in recent years that there has been any detailed research into the various problems relating to these parasites.

Officers of the C.S.I.R.O. at its Veterinary Parasitology Laboratory, near Brisbane, have already made substantial contributions to our knowledge of this important subject, and it is probable that more attention is being given to this work here than anywhere else in the world.

A survey carried out by C.S.I.R.O. officers has revealed that as many as 8 per cent. of calves in dairy herds in

Queensland may be lost through parasitic worm infestations. Mortality is also often high among beef weaners in the higher rainfall areas. Nevertheless the greatest monetary loss from worm infestations in both dairy and beef cattle results, not from the death, but from the failure of young stock to thrive and grow at a normal rate following heavy infestations.

The majority of outbreaks among dairy cattle occur in calves aged from four to 12 months and among beef cattle shortly after weaning.

Whilst this work in Queensland is very useful, the climatic conditions are somewhat different from ours and the findings are not completely applicable to the problems here.



Fig. 1.—Calves like these are probably carrying a heavy worm burden, as indicated by their poor condition, harsh “staring” coats and dull-eyed listlessness

However, there has been a gradual extension of the work to the winter rainfall areas and as a result, useful knowledge is being acquired of the problems in these areas.

Investigations by officers of the Department of Agriculture have shown that the worms responsible for most of the trouble in cattle in this State are confined mainly to two types—the Small Brown Stomach Worm or *Ostertagia* spp. and the Small Intestinal Worm or *Cooperia* spp.

The life histories of these worm parasites have many common features. Eggs are laid by the females whilst in the intestines and pass out with the dung. There they hatch and undergo further development until they reach the infective stage, which takes about one week in the summer and two to three weeks in the colder weather. When conditions are favourable, they leave the dung and migrate onto blades of grass where they are picked up by the stock when feeding. If external conditions are unfavourable however, they may survive for at least six months in the dry dung, and for this reason alone, the practice of breaking up the dung and spreading it by harrowing has a most useful application.

Once inside the animal, the larvae make their way to a specific section of the bowel depending on the species of worm. The worms may then reach maturity in as little as a fortnight.

The Small Brown Stomach Worm is a slender brownish worm about $\frac{1}{2}$ in. in

length which is found in the fourth stomach, but particularly near the opening of the stomach into the small intestine. Because of their small size they may easily be overlooked at a post-mortem examination.

When swallowed, the infective larvae penetrate into the walls of the stomach and remain coiled up in small nodules. Later they leave the wall and develop to maturity in the stomach lining where they suck blood. For this reason they may be extremely dangerous and heavy infestations can lead to anaemia, diarrhoea and death.

This worm is confined mainly to the cooler areas and heavy infestations are likely to occur during the winter months in winter rainfall areas.

The Small Intestinal Worm, which is also very active in this State is a worm about $\frac{1}{4}$ to $\frac{1}{2}$ in. long, and like the stomach worm may be present in thousands and yet still be missed by the inexperienced observer. It has a reddish colouration when fresh and again like the stomach worm is a blood-sucker.

Young calves are chiefly affected and may carry heavy infestations even when three to four months old.

With both of these parasites, there may be a gradual build-up of resistance by the animal so that by the time stock are 12 to 18 months, most of the worms have been eliminated. However, considerable damage, if not actual death, can be caused prior to this age.

The most common symptom of worm infestation is a progressive loss of condition. As feed is often scarce during the winter months, this loss of condition may easily be attributed to lack of feed, rather than worm infestation. Lice infestations are also common at this time and the combined effects of poor feed and worm and lice infestation may play havoc with young stock.

Diarrhoea is usually present with worm infestation and the coat becomes dry and harsh and ultimately affected calves may get so weak that they find difficulty in standing or are unable to do so.

Cobalt deficiency may produce very similar symptoms so that in cobalt-deficient areas it is necessary to make sure that this is not a complicating factor. Cobalt deficient cattle will respond very rapidly

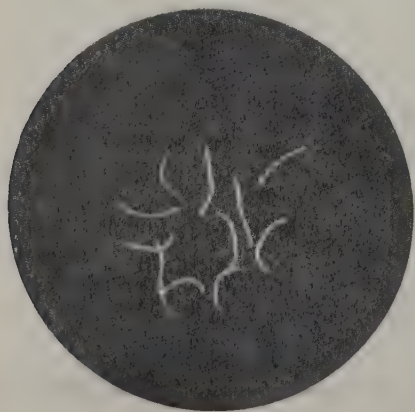


Fig. 2.—Small Brown Stomach worms (*Ostertagia* spp.)

to cobalt supplementation and the newly-developed cobalt bullets for cattle should be useful for this purpose.

Worm infestation may be diagnosed on the symptoms previously described, together with a post-mortem examination of an affected animal if possible. There are special methods of staining and counting the numbers of worms, and also of identifying the particular species involved. Faecal examinations are not always reliable on their own.

One of the difficult features of the treatment of worm infestations in cattle is the relative inefficiency of anthelmintics which have considerable value for the removal of sheep parasites. Phenothiazine and bluestone-nicotine sulphate which are used so much for worm infestations in sheep are not very satisfactory for the prevention or treatment of worms in calves. They are frequently used, of course, but against the worm species mainly found in this State they are not very efficient.

It has been found, however, that dosing with a 5 per cent. solution of bi-carbonate of soda—that is, one ounce of bi-carbonate to one pint of water—at the rate of about $\frac{1}{2}$ pint immediately before drenching with either phenothiazine or bluestone-nicotine sulphate, will improve their efficiency. This is because the bi-carbonate of soda has an effect on the oesophageal groove, closing it and enabling the drench to go straight to the fourth stomach instead of into the paunch.

A certain amount of care is necessary in dosing calves with phenothiazine due to the possibility of a type of photosensitisation which may have severe effects on the eyes. For this reason treated calves should be kept out of direct sunlight for up to 36 hours after drenching. Generally, however, if they are kept in a shed, the day after drenching, little trouble should result.

Treatment should be repeated in about 14 days and then every three to four weeks, particularly if conditions are favourable for the development and pick-up of worm larvae but generally if paddock rotation is practised and the calves can be kept off low-lying wet areas, re-treatment may not be necessary.

However, the most important thing to realise with worm infestations in both cattle and sheep, is that prevention is

much more satisfactory and that dosing is really too late when carried out as a treatment rather than a preventive measure.

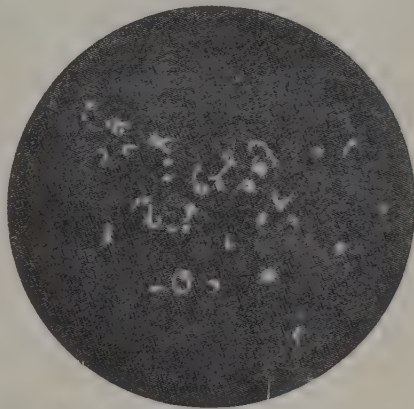


Fig. 3.—Small Intestinal worms (*Cooperia* spp.)

A good deal of research work is being carried out at the present time in an effort to develop a more satisfactory anthelmintic for cattle than the present ones, but so far no drench which can be considered both efficient and safe has been found. One preparation, known as Neguvon, was found to be very efficient against the types of worms found in this State and high hopes were held for it in the field. Strangely enough it was found to be relatively safe when used in Queensland where it is still being used, but in Victoria and also in this State, toxic effects, including the collapse of treated calves, were observed. While the collapse could be readily overcome by injections of atropine, it was, of course, realised that it was not a method of treatment that could be placed in the hands of farmers.

However, as with most disease conditions prevention is more important than treatment and worm infestations can generally be kept at a minimum where good husbandry methods are practised. Such factors as the avoidance of overstocking, the rotation and spelling of calf paddocks and the maintenance of good nutritional conditions by adequate feeding are all important in the prevention of worm infestation in cattle.



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Weed Research...



by **G. A. PEARCE** B. Sc. (Agric)
BOTANIST, WEEDS & SEEDS BRANCH.

6.—WEED CONTROL IN CHANNELS

PROBABLY the major task involved in maintaining drainage and irrigation channels is the regular removal of weed growth. The cost of hand chipping a standard head channel is approximately 10s. per chain. The use of suitable chemicals could reduce this cost considerably.

Early trials in this State were undertaken with the object of removing the weed growth present and preventing any further growth for a considerable period. Even when the channels were chipped first, satisfactory control was not obtained, using economical rates of application. It is now felt that under most conditions a number of applications at regular intervals throughout the growing season is the practical solution.

With the wide range of chemicals available it is most important that the appropriate weedkiller be used for any particular weed.

SPRAYING PROGRAMME

When considering the use of chemicals for controlling weed growth it should be remembered that regular attention is required to ensure the success of any treatment. Weed seeds are constantly



Fig. 1.—Channels with a heavy growth of weeds greatly reduce the flow of water and cause wastage

Fig. 2.—Any mechanical work required on channels should be undertaken before chemicals are applied



germinating and perennials will grow into the channel from the banks, so that scattered but regular spot spraying will always be required.

In many cases the channels require reshaping as well as the removal of weeds to ensure a good water flow. Under such conditions chemicals should be only used to kill weed growth after any mechanical work has been undertaken.

If the physical condition of the channel is satisfactory it should be remembered that a heavy mature growth of weeds is much more difficult to control than young quick-growing plants. Under these con-

ditions an extra application is often required.

In general, most spraying should be undertaken during the late spring or summer period. The treatments should be applied as long as possible before the next flow of water so that the chemicals have time to be absorbed into the plants. Most chemicals are much less effective when applied to weeds growing in water.

CHEMICALS

Several of the chemicals listed are relatively slow-acting and in some cases beneficial results may not be seen for as



Fig. 3.—Hand chipping is costly and very tedious and a large proportion of it can be replaced by the proper use of chemicals



Fig. 4.—Weeds growing in water are more difficult to control than when the channel is dry. Spraying should be planned for when the water level is at a minimum

long as six weeks after treatment. New growth on the weeds usually indicates that the chemical is no longer having the required effect.

1.—Dalapon (Sodium dichloropropionate).

This chemical is a selective grass weed killer which is absorbed through the foliage. Because of this, dalapon has a number of advantages over root-asorbed chemicals, the most important being, that it is not so greatly influenced by the moisture condition of the soil.

A wetting agent should always be added to the mixture.

Dalapon is not poisonous to animals but at the rates of application recommended would be harmful to most pasture plants.

Dalapon is recommended for the control of perennial and annual grasses.

(1) *Perennial Grasses.*

In the case of perennials, complete control cannot be expected with a single application. It is generally accepted that two applications are much more effective than a single treatment using twice the quantity. For this reason for the control of grasses such as couch, paspalum and kikuyu two applications at the rate of 25 lb. of 85 per cent. dalapon per acre is

recommended. The second treatment should be three to six weeks after the initial spraying, and immediately new growth appears. A suitable solution is made dissolving 1 lb. of dalapon in 6 gallons of water and this quantity would be sufficient to treat five chains of channels spraying a strip five feet wide.

For irrigation channels, a spraying programme could be commenced during the late spring and extended throughout the summer. Regular follow-up treatment will be necessary and this should be undertaken preferably when there is little water in the channels.

(ii) *Annual Grasses.*

For the control of annual grasses the rate of application can be decreased to 1 lb. in 15 gallons of water.

2.—Amitrol (Amino triazole).

Amitrol can be used as a general purpose weedkiller in water channels. It is particularly effective against broadleaved weeds as well as giving good control of grasses. Amitrol is absorbed fairly quickly by the foliage and through the roots.

For general weed spraying the rate of application should be 30 lb. of 50 per cent. amitrol per acre. A suitable solution is



Fig. 5.—The rushes growing on a three feet strip on either side of this drain have been controlled by the use of 2,4-D ester. Note the size of the original growth

made by dissolving 1 lb. in 5 gallons of water and this quantity would be sufficient to treat approximately four chains of channel spraying a strip five feet wide.

Overseas trials have shown that amitrol mixed with dalapon makes a particularly effective spray for the control of perennial grasses and hard-to-kill broad-leaved weeds when growing together. A suitable solution for testing purposes would be 1 lb. of 50 per cent. amitrol mixed with 2 lb. of dalapon in 10 gallons of water.

3.—2,4-D (2,4-Dichlorophenoxyacetic acid).

The ester derivatives of 2,4-D have proved most effective when used for the control of channel weeds, such as cum-bungi or yanget, umbrella grass and a number of species of rushes. The susceptibility of rushes varies considerably with the species. Weed growth consisting of broad-leaved weeds, susceptible to 2,4-D and grasses can be controlled by spraying with a mixture of 2,4-D and dalapon.

Where 2,4-D is effective the cost of treatment is relatively small.

Work undertaken by the Victorian Water Supply Commission has shown that oil-based esters of 2,4-D are the most effective, and a number of proprietary lines are specially formulated for use against channel weeds. Although the more common ethyl ester is volatile it is quite safe to use in pasture areas. Where susceptible crops, such as vines or vegetables,

are in the vicinity, care is required when spraying and a low-volatility ester should be used.

(i) *Cumbungi or Yanget.*

Good control of this rush can be obtained if the treatment is applied to new growth after cutting or burning. Spraying when the re-growth is three to six feet tall is recommended, and preferably during the period November to April. Eight pounds acid-equivalent of 2,4-D ester in 200 gallons of water per acre is recommended. A suitable solution is made by dissolving 1½ fluid ounces of 40 per cent. 2,4-D ester in one gallon of water and this is sufficient to treat 24 square yards. Any regrowth should be treated as it appears.

(ii) *Umbrella Grass (Cyperus eragrostis).*

This sedge has become a problem in many irrigation areas. Trials have shown that it can be controlled by spraying with a solution containing 2,4-D ester at the rate of 4 lb. acid-equivalent in 150 gallons of water per acre. Variable results have been obtained using different proprietary lines and it is desirable to use an oil-based ester with generous amounts of emulsifier and wetting agent. Spraying should be undertaken shortly before flowering.

(iii) *Rushes.*

The susceptibility of rushes varies considerably with the species present. Because of this, proper identification is

necessary before recommendations can be made. The tall-growing cultivation rush can be controlled by spraying with 2,4-D ester at the rate of 3 lb. acid-equivalent in 200 gallons of water per acre. A suitable solution is made by dissolving one fluid ounce of 40 per cent. ester in two gallons of water and this is sufficient to treat 40 square yards. The other common rush in the irrigation areas is *Juncus pauciflorus* which does not have a standard common name, although it is sometimes referred to as the slender rush. This species is more difficult to control and the rate of application recommended for cultivation rush should be doubled.



Fig 6.—The grass growing in the bottom and lower portions of the side slopes of this drain has been controlled by the application of dalapon. The chemical was applied when the drain was empty

With all rushes, best results are obtained if the spraying is undertaken during the early summer when the plants are making active growth. At other times of the year the rushes should be cut and the chemical applied after a fair amount of regrowth has appeared.

Several of the other rushes which do not occur in water channels can be controlled but many are resistant to chemicals. For this reason identification should

always be established before undertaking spraying.

4.—C.M.U. (Chlorophenyl dimethylurea).

This chemical applied at high rates of application is a soil sterilant. However its high cost precludes its general use.

(i) Water Couch.

The Victorian Water Supply Commission has found C.M.U. to be the most effective chemical for the control of this weed. They have found it necessary to expose the soil containing the roots and remove the top growth of the weed before applying C.M.U. at the rate of 50 lb. per acre. This of course means that the channels should be clear of water to obtain best results. A suitable solution would be made by dissolving 1 lb. of C.M.U. in four gallons of water and this is sufficient to treat approximately 96 square yards. Because the chemical is absorbed through the roots it is essential to use a high volume of water and obtain an even application.

COST

At the rates of application mentioned the cost will vary considerably with the chemical used. Using 25 lb. of dalapon per acre the cost of treating one chain of channel will be approximately 2s. 9d.; 2,4-D ester at the rate of 8 lb. acid-equivalent per acre would cost approximately 1s. per chain for chemical; C.M.U. at the rate of 50 lb. per acre would cost approximately 22s. per chain. These figures are for treating a strip five feet wide and only apply to the cost of the chemical used. Hand chipping usually costs in the vicinity of 10s. per chain.

PASTURE AND STOCK

At the rates of application mentioned all these chemicals are particularly harmful to pasture plants, however, they are not toxic to animals.

EQUIPMENT

Spraying equipment should be thoroughly washed with warm soapy water immediately after use. Garden or orchard spray equipment should NOT be used for the application of 2,4-D.

SUMMARY

- (1) A large proportion of the hand chipping of water channels can be avoided by the proper use of weedkilling chemicals.
- (2) Most weeds growing in channels cannot be killed with a single application of a chemical. Follow-up spraying is always required.
- (3) A number of weeds including some rushes are quite resistant to chemicals.

(4) To obtain best results a planned spraying programme should be adopted incorporating regular inspections.

(5) Table 1 lists the more common weeds and the recommended chemical to use. This should be read in conjunction with the text.

REFERENCE

Dunk, W. P.—State Rivers and Water Supply Commission, Victoria. Weed Control in Irrigation Channels and Drains. Annual Progress Reports.

TABLE 1

Weed	Time for Spraying	Chemical	Rate	Estimated cost per chain
Perennial grasses, e.g., couch, kikuyu, paspalum, etc.	Active growth period	Dalapon	1 lb./6 gals.	2/3
Water couch	Roots active, channels dry	C.M.U.	1 lb./4 gals.	22/-
Annual grasses	Before seeding	Dalapon	1 lb./15 gals.	1/-
Broad leaved weeds and annual grasses	Active growth period	Amitrol	1 lb./5 gals.	3/9
Broad leaved weeds and perennial grasses	Active growth period	Amitrol and dalapon or 2, 4-D ester and dalapon	1 lb. amitrol and 2 lb. dalapon/10 gals. 5 fl. ozs. 40% 2, 4-D ester and 2 lb. dalapon/10 gals.	4/6 3/-
Cumbungi	When new growth is 3-6 ft. tall	40% 2, 4-D ester	1½ fl. ozs./gal.	1/-
Umbrella grass	Before flowering	40% 2, 4-D ester	1 fl. oz./gal.	6d.
Susceptible rushes	Active growth period	40% 2, 4-D ester	1-2 fl. oz./gal.	6d. to 1/-

Table 1 lists the more common weeds found in water channels and the recommended chemical for their control. Column 4 shows a suitable solution and the area this is sufficient to treat is given in the text.

W.A. SHEARING BOOKLET POPULAR OVERSEAS

An attractively-printed, green-covered booklet bearing the title "SKAAPSKEER TEGNIEK" which recently arrived in Perth from South Africa, is a reprint in Afrikaans of "Sheep Shearing Technique" an article which originally appeared in "The Journal of Agriculture of Western Australia."

This article was written by Messrs. W. L. McGarry, D. A. Young and M. Butler, of the Sheep and Wool Section of the W.A. Department of Agriculture. It was reprinted as Departmental Bulletin No. 2409 and was widely acclaimed throughout Australia as the best-presented and most informative approach to the subject that has yet been published.

The authors arranged with the Government Photographer to take a series of pictures showing each stage of the shearing operation from the removal of the sheep from the catching pen, through each of the shearing "blows," to its release after removal of the fleece. Each picture was accompanied by a concise but informative caption designed to ensure better and easier shearing.

Many requests for permission to republish the article were received from other Departments of Agriculture, technical schools, and agents for shearing equipment, and its republication in South Africa is a tribute to the quality of the work.

Coccidiosis

IN SHEEP

By J. M. ARMSTRONG, B.V.Sc., Veterinary Surgeon

COCCIDIOSIS is an acute, contagious intestinal infection which may affect most species of animals and birds. The disease causes heavy losses in the poultry industry, and dogs, calves, sheep, goats and pigs are among other domesticated animals affected—but there is no cross-infection from one species of animal or bird to another. It is characterised by diarrhoea and severe loss of condition.

Coccidiosis in sheep is not commonly encountered in Western Australia but an outbreak which occurred recently in the Albany area caused the death of 20 lambs.

In this instance, a flock of 350 Merino ewes about three weeks prior to lambing were placed in a 100-acre lambing paddock containing 60 acres of short pasture and 40 acres of oaten stubble. They were kept in the paddock for seven weeks and then the ewes with about 250 lambs were moved to a 150-acre paddock of short pasture.

About this time there was an appreciable fall of rain and not long afterwards, the lambs commenced to scour. Within three weeks 20 had died and nearly all the lambs received a severe check. After treatment with sulphamezathine was commenced, there were no more losses and all lambs improved.

CAUSE

Coccidiosis results from infection with coccidia which are microscopic parasites belonging to a very large group of organism known as *Protozoa*.

Like many other internal parasites, the coccidia have very complicated life-cycles but in brief the sequence is that the infection is picked up from sheep droppings on the ground in the form of oocysts which are a dormant stage of the parasite. On reaching the small intestine, the dormant oocysts release active forms known as sporozoites which invade and destroy the intestinal walls. Here they divide and increase their numbers enormously.

Subsequently, more oocysts are formed and these are passed out in the droppings

to contaminate the ground and, when these are picked up by the sheep, the life-cycle recommences.

CONDITIONS OF SPREAD

Coccidia are frequently present in small numbers in the intestines of apparently normal sheep and under most conditions, are passed in the droppings and scattered around the paddock where they are exposed to the direct sunlight, which destroys them. If, however, stocking rates are high or animals are fed at one particular spot so that the ground and feed there becomes heavily contaminated with sheep droppings, large numbers of coccidia will be eaten. These multiply in the intestines, before being passed out to further contaminate the area, thus setting a vicious cycle in motion. This build-up is intensified if conditions are moist—as this favours the survival of the coccidia in the faeces—thereby increasing the chances of them being picked up by other sheep. Trough feeding of young animals in one part of the paddock provides suitable conditions for an outbreak; thus in lambs reared in feed-lots in the U.S.A. this disease is frequently encountered. Of the outbreaks which have occurred in Western Australia, many have been under handfeeding conditions which bore some resemblance to the American feed-lot systems.

SYMPTOMS

Young sheep, usually four to six weeks of age, but sometimes weaners also, develop an offensive profuse diarrhoea of a

dark brown colour which may be streaked with blood. Affected sheep become tucked-up, pot-bellied and anaemic, while odd ones may become paralysed. There is no fever. Although most of the lamb flock may be affected, and 50 per cent. of them may be scouring badly, the mortality rate is not high—usually less than 10 per cent.—and losses from decreased production and poor growth are frequently more severe than losses from deaths.

POST-MORTEM APPEARANCES

On post mortem examination, changes are seen to be confined to the intestines which show lesions ranging from a patchy inflammation with scattered small, yellow, circular areas, to more chronic cases where the diameter of the intestine is increased to several times its normal size due to large numbers of papillamatus masses in its wall. These wart-like mases which are up to $\frac{1}{2}$ in. in diameter are usually scattered along several feet of the intestine. The contents of the large bowel are quite fluid, foul-smelling and sometimes flecked with blood.

DIAGNOSIS

A presumptive diagnosis of coccidiosis may be made from the flock history and a clinical examination of sick sheep, but a post-mortem examination, preferably backed by a laboratory confirmation, is necessary to definitely establish the presence of this disease.

There are two main conditions which are superficially somewhat similar to coccidiosis. These are black scour worm (*Trichostrongyle*) infestations and paratyphoid (salmonellosis).

There is a difference in the colour of the scour occurring in coccidiosis and scour worm infestations, the coccidial scour being chocolate-coloured and possibly blood-streaked as compared with the black scour of "wormy" sheep; also a history of recent drenching would tend to rule out worms. Despite this, a post-mortem examination is indicated to differentiate between these two conditions.

Paratyphoid should not be confused with coccidiosis as in paratyphoid there is a fever, and animals dying will show inflamed membranes with small haemorrhages throughout the body. Also any older sheep in contact with the lambs would probably be also affected.

PREVENTION

Precautions should be taken to avoid feeding young sheep on ground heavily contaminated by sheep droppings. Grain given as a supplementary ration should be fed out onto a clean area away from the sheep camps and watering points, and the site of distribution should be changed at frequent intervals. If sheep are on pasture they should be rotated as often as is practicable. The higher the stocking rate, the more important this is. **Avoid keeping sheep concentrated in small areas for long periods.**

TREATMENT

Affected sheep respond well to subcutaneous injections of sulphadimidine (Sulphamezathine) at the rate of 1 gram per 15 lb. bodyweight given daily for three to five days (1 gram is equivalent to 3 cc. of a 33 $\frac{1}{3}$ per cent. solution).



UREA

As a Protein Supplement

To Dry Summer Pastures

By F. E. FELS, B.Sc.Ag. (Hons.), Research Officer, A.H.N.L.

UREA, a crystalline compound manufactured from the nitrogen of the air, is used in the U.S.A. as a fertiliser for various crops. It is also used in grain mixtures by American stock-raisers to fatten cattle in feed-lots, and could become a common supplement in Western Australia where grazing stock live on dry roughage for some months of each year.

Growing plants use nitrogen fertilisers to form plant protein. Bacteria in the rumen (first stomach) of sheep and cattle can use urea in the same way to form bacterial protein. In the normal course of events the rumen bacteria pass into the fourth stomach and intestines of the animal and are digested. Thus fertiliser nitrogen is converted to bacterial protein in the first stomach, and this protein is later digested by the animal.

TOXICITY

Urea is fermented to ammonia in the rumen before the bacteria use it. They absorb the ammonia and form protein which is utilised in growth. To make sure that the rumen bacteria have enough feed for rapid growth, urea should be fed with grain or molasses.

If urea is fed without grain or molasses, or in large quantities, ammonia accumulates in the rumen and can easily poison the animal.

Urea feeding is especially risky if the animals are empty at the time of feeding.

WHEN TO FEED UREA

Dry pastures rarely contain much protein unless they are moderately clover-dominant. Sheep diets are commonly deficient in protein in summer, and the West Australian sheep industry depends on the fact that sheep can survive some months of severe underfeeding without marked ill-effects other than the normal loss of condition.

Urea should be useful whenever sheep and cattle are grazing dry non-clover pastures or crop stubbles.

UREA-GRAIN MIXTURES

Hand-feeding with grain is a common practice during the "annual summer drought," but protein concentrates would be much more effective. The addition of 3 lb. of urea to each 100 lb. of grain converts it to a 17 per cent. protein concentrate and $\frac{3}{4}$ lb. of a pound of this mixture would supply the daily protein needs of a dry sheep even if no pasture was eaten.

Three pounds of urea per 100 lb. of grain gives a good general-purpose mixture, but in the beginning it would be safer to use less, say $1\frac{1}{2}$ lb. of urea per 100 lb. of grain. The $1\frac{1}{2}$ per cent. mixture should also be used if you feed only small quantities of grain, such as $\frac{1}{4}$ lb. a head each day, or 1 lb. a head once a week.

Dissolve the urea in water, sprinkle it on the grain, and mix it well. A concrete mixer is the ideal machine for this work, and the urea solution can be sprinkled onto the grain from a watering can while mixing. Only a little water is needed.

Dry-mixing is dangerous as urea crystals or powder can settle to the bottom of bags or feed-troughs, allowing stock to get an overdose.

UREA-MOLASSES SPRAYS

Grain will probably be the most popular vehicle for administering urea, but research workers at Melbourne University

are investigating urea sprays for dry pastures and stubbles.

A flock of 1,000 sheep can be expected to eat about a ton of dry pasture per day. A day's supply of urea and molasses for a flock should be sprayed on an area that will provide a day's supply of pasture. For 1,000 sheep in a paddock containing the equivalent of a ton of hay per acre the urea-molasses mixture would be sprayed on one acre.

A suitable supplement would be 30 lb. of urea and 100 lb. of molasses per ton of dry feed. The urea is dissolved in water, mixed with the molasses, and enough extra water is added to make the mixture sprayable. It is applied with a boom spray to the proper area of pasture. In practice, four or five day's supply could be applied at one time.

Stock may ignore the sticky pasture at first, and may need to be trained by confinement in a small paddock of treated feed.

The feature of pasture spraying is that there is no danger of poisoning as the daily dose of urea is eaten in many small portions through the day.

UREA SPRAYS FOR GROWING CROPS

Urea can be sprayed on to the foliage of growing crops as a fertiliser. Applied late in the growing season, say in September, this will not increase yields but will increase the protein content of the crop.

In a recent radio talk, Mr. R. J. Moir of the West Australian University mentioned that 30 lb of urea per acre dissolved in six gallons of water were sprayed on portion of a growing oat crop in September 1958. The crop was cut for hay at the normal time and analysis showed that spraying had increased the protein content of the hay from 6 per cent. to 8½ per cent. All the fertiliser nitrogen remained in the hay, presumably as plant protein.

This is the most attractive way to add urea to hay, and involves no danger of urea poisoning as the urea is converted to protein in the plant.

The same procedure would greatly improve cereal crops that are left unstripped as sheep feed.

COSTS

At £83 per ton, urea costs 9d. per lb.

Grain Mixtures.

Three pounds of urea for 100 lb. of grain costs 2s. 3d. The cost per bag of oats is 2s. 9d., and this converts it from a 10 per cent. to a 17 per cent. protein concentrate.

Urea-Molasses Spray.

The cost of 30 lb. of urea and 100 lb. of molasses for a ton of dry feed is about £3.

Urea Fertilisers for Hay Crops.

The cost of 30 lb. of urea for an acre of crop to be cut for hay or left unstripped for grazing would be £1 2s. 6d.

Labour and other costs are lowest when urea is sprayed on growing crops, and still quite low when it is mixed with grain. Costs are much higher for urea-molasses spraying.

PRECAUTIONS

Urea feeding is certainly risky, but most accidents are due to some definite mistake. Some precautions are suggested below:—

Urea should be weighed, and mixed with the proper quantity of grain.

Bags of urea should not be left where house cows or stud rams can mistake them for salt licks.

Solutions and mixtures containing urea should be kept in safe places away from stock.

For valuable animals such as rams it might be advisable to feed sheepnuts or double quantities of untreated grain, rather than run the risk of making a mistake with urea.

Feed grain in exceptionally long, thin trails.

Feed urea-grain mixtures when the stock have full stomachs, say at 9.0 a.m. when they have just finished their morning grazing. They will then eat more slowly, and this reduces the risk of poisoning.

Do not mix dry urea with grain—it might settle out.

For added safety, 1½ lb. of urea per 100 lb. of grain should be used at the commencement of grain feeding, and also if you feed rather small quantities of grain or feed irregularly.

CONCLUSION

Urea is a suitable type of nitrogen fertiliser with which to increase the effective

protein content of grain, hay, and dry pastures for sheep and cattle. It will be most useful in the outer wheatbelt beyond the "clover belt," but would be worth using in the clover areas when stock are grazing grass-dominant pastures, cereal stubbles or standing crops.

The cost of urea itself is low, but the cost of hay or grain to feed it with is just as high as it always has been. However, people who feed hay and grain will find that the addition of urea to grain or the spraying of urea onto hay crops will help them get more value for their money.

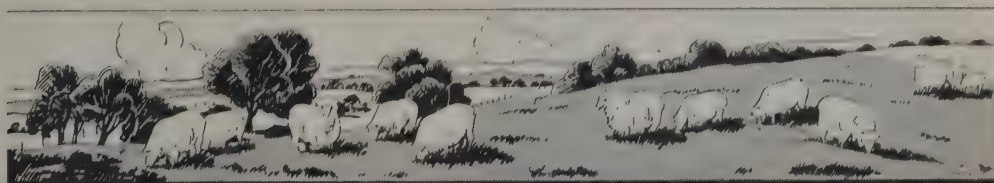
Using a spray of urea and molasses on dry pastures or stubbles avoids the cost

of grain or hay, but the job is tedious and the costs are rather high. A small daily feed of urea-grain mixture would cost no more and would be much more convenient.

Most people who feed urea learn by experience that mistakes happen easily. The fear of a "mistake" is the main deterrent to the use of urea.

ANTIDOTE

A cup of sugar dissolved in half a beer-bottle of water, and mixed with half a bottle of vinegar, should be given to affected sheep as a drench. The flock should be given a generous feed of untreated grain.



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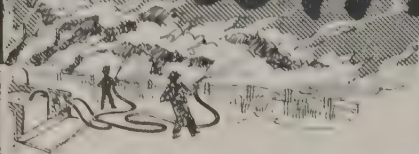
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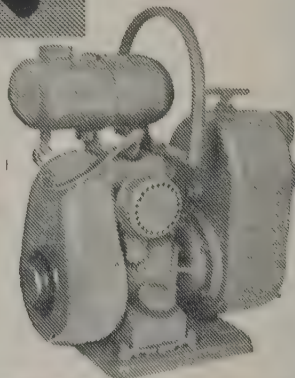


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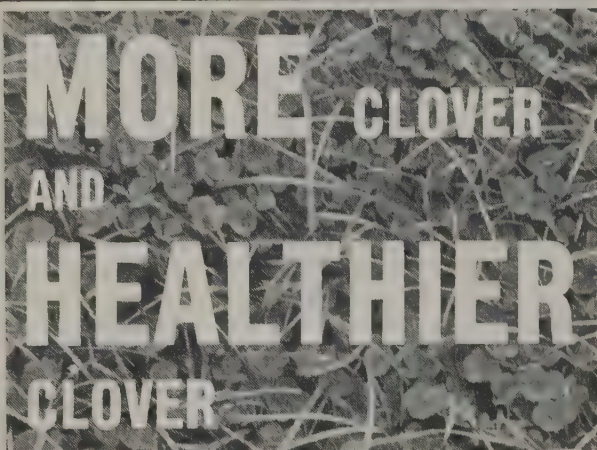
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Fig. 1.—A good bunch of Wortley Hall grapes ready for picking in late July

Winter Grapes on the Gascoyne

By ROBT. HARINGTON
(Dip. Agr. Potchefstroom, South Africa)



AN interesting experiment was carried out at the Gascoyne Research Station earlier this year, to ascertain whether table grapes could be added to the list of crops which can be grown commercially on the Gascoyne.

Up to date, the growing of grapes in the Gascoyne area has been limited to the home gardens, where the strong vigour, healthy growth and good bearing habits of the vines have demonstrated the suitability of the area. However, the vines produce only during the summer months when a buyer's market is available, and this limits production to that required for local domestic consumption.

Carnarvon receives comparatively little rain, and grapes must be irrigated throughout the year. Under normal watering and pruning procedure, grape vines behave just as they do in the Perth climate, fruiting in summer and remaining dormant throughout the winter months. The Carnarvon winter, however, is warm and sunny. This enables growers to produce winter tomatoes and beans—so why not grapes?

With two experimental vines, a white Wortley Hall and a muscat—Gordo-Blanco, a dormant period was induced by withholding water for four weeks in February and March. During the third week the vines were pruned hard, spurs being cut back to two buds each.

After the four weeks resting period a light application of sulphate of ammonia was worked into the soil around each vine to a depth of two inches, care being taken to avoid contact with the stem and basal roots of the plant, and irrigation water was applied. Thereafter, watering continued on the normal summer schedule of 2½ in. per week.

During late June the best quality bunches were covered with paper bags, for protection against bird damage. This protection however, proved quite unnecessary, as no damage was recorded on the



Fig. 2.—One of the vines in the early stage of bunch development

other uncovered bunches. The absence of birds during this time of the year will certainly be of great advantage if winter fruiting can be commercialised.

Irrigation was discontinued when the grapes began to ripen.

During the last week of July, 20½ lb. of excellent quality grapes were harvested from the Wortley Hall vine. The bunch weights of marketable fruit varied from 1 lb. to 3½ lb. These grapes were sent to the Metropolitan Markets, were sold by private treaty, and realised a retail price of 3s. 6d. per lb. Such a price would be unheard of in the normal summer grape season, so there is some encouragement to further investigation along these lines.

While this encouragement came from the white Wortley Hall, it must be recorded that the yield from the muscat, Gordo-Blanco, was low, and the bunches too small for marketing purposes.

Further experiments will be carried out to determine which varieties will respond and whether commercial yields of marketable fruit may be expected. Treatments too, can be varied considerably in Carnarvon climate, and we must determine by trial, the best time and period of forced dormancy.

Where the method has been used overseas, it has been shown that the life of the vine is somewhat shortened and yields materially reduced. This is to be expected of course, because the normally extended dormant period is reduced by about half. Commercial possibilities would, therefore, be dependent upon the readiness of Perth consumers to pay a high price for grapes in winter time, and confirmation of this by trial consignments becomes just as important as the experiment concerning methods of producing the fruit.



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PLANTAGENET PEATY SAND

By F. E. RYAN, Agrostologist.

VISITORS to the south coast appreciate the colourful bottlebrush growing along the flats and many ask why this land is not used for farming. The reason is that they are part of the Plantagenet peaty sand series and these are problem soil types. These soils are very acid, sandy and peaty, they are poorly drained and may even be under water during the winter months. They contain a mass of fibrous roots in the top 8 to 10in. and this fibrous material will not rot down even when fully cultivated. The sand is greasy and does not wet easily. Even after six inches of rain the soil may have a dry band $\frac{1}{2}$ in. below the surface even though there is a free water table five inches below.

On the other hand, the area of Plantagenet peaty sand is estimated to be up to 200,000 acres in extent. It occurs on most farms in the South Coastal areas and in many cases is associated with higher lands suitable for winter grazing. It occurs in a rainfall area with from 36 to 60in. of rain per annum, and on some sections will remain moist through the whole of the summer period. It is land, therefore, which is worthy of further consideration.

In recent years a lot of experimental work has been carried out on this problem soil. Since it is acid in reaction, lime appears necessary. Very good responses to lime applications have been obtained and at Denmark where rates from 1 to 8 tons per acre were tried—1 ton was found to be as good as 8 tons. On most sites lime appears necessary but on some areas subterranean clover pastures have been established without the use of lime. Further

work is being done at present to determine whether rates of lime less than 1 ton per acre can be used.

The soils lack phosphate and in most trials 4 cwt. per acre of superphosphate has been used in the first year. Copper appears to be lacking in these soils and there is some evidence to suggest that zinc is also lacking, although this appears to vary from place to place.

In common with most peaty soils, these areas are very low in available potash, and strong responses to applications of potash have been obtained. If extensive areas are developed they will undoubtedly need potash soon after they are developed if not in the first year.

A number of pasture plants have been tried. Yarloop subterranean clover succeeds very well and good results have been obtained with Tallarook subterranean clover. Areas which are liable to dry out in the summer time may not support per-

ennials but on much of the area strawberry clover and possibly white clover could be grown once the area had received an application of lime and trace elements.

In trials, subterranean, white strawberry, red and Alsike clovers, lupins and vetches have been grown. The most successful grasses so far tried have been kikuyu and phalaris.

To develop this country it is necessary to destroy many of the roots and fibres in the soil and cultivation methods have been tried. Rotary hoeing has not been very successful as it buries the roots and top growth if not burnt prior to cultivation. Disc ploughing has been more successful. The attempt must be to throw the land up into heavy clods to allow it to dry out and then fire it in an attempt to burn the top growth, roots and fibres which have been exposed. Another method is the use of rippers which tend to lift the roots and fibres to the surface where they may be burnt. If sufficient root material can be destroyed in this way it is much easier to prepare a seed-bed suitable for pasture establishment.

There are problems too of grazing management. Areas which were established many years ago using animal manure were

found to revert quite quickly to an unproductive sod-bound Yorkshire fog sward. Methods of grazing and cutting in an attempt to overcome this problem are being tested.

You will have gathered from what I have said that we do not have all the answers to Plantagenet peaty sand but information is being collected, you will also realise that establishment on this land is neither easy nor cheap. It is important to know just how productive this country can be made before it will be clear whether development is an economical proposition. If you have in mind developing some of this land, make sure that it is fairly deep, i.e., coffee rock is not too close to the surface. It will need drainage and there must be some outlet for drainage water. Cultivation implements will be necessary to lift the roots and it may be two or even three years before it can be brought into production. If it is under production, careful grazing management will probably be necessary and in preparing the paddock it should be brought into a condition suitable for mowing as quickly as possible.

Plantagenet peaty sands present a challenge and we are still trying to find the answer.

HIGHER GRAIN PRODUCTION

By H. M. FISHER, Agricultural Adviser.

THERE is in evidence at the present time that, in the cereal areas, falls in returns from wool can best be offset by greater emphasis on cereal grain production. This is in fact an expression of the versatile nature of farming in these areas today.

The question which is uppermost is "How can grain production be most profitably increased?" It is a question which is receiving a great deal of attention throughout Australia, not only in relation to more efficient and greater total production but towards improvement in "saleability" of grain produced. You have heard for instance that monies recently made available by the wheat industry and generously supported by the Commonwealth Government are at the present time being utilised by the Departments of Agriculture and

other bodies in an exceedingly comprehensive probe into problems of wheat production and marketing.

It is intended in this brief talk to suggest a few of the aspects we might think about in our efforts towards a larger and more profitable harvest.

One question is of course "On what cereal should emphasis be placed?" The answer is governed as much if not more by the special virtues of various cereals in the farm programme as by the demand for them.

At the present time there is a satisfactory local and overseas market for all grains. Beecher barley and Ballidu oats in particular are increasing in popularity overseas. Wheat, however, with its higher price and assured market under stabilisation will no doubt be given preference in many areas.

Consideration must be given nevertheless to the possible embarrassment of large wheat stocks; the higher yielding ability of oats in wetter districts and their resistance to insect pests and fungal root-rots that can affect the yield of both wheat and barley; the suitability of barley for many areas of new light land and the dual-purpose nature of both oats and barley in providing sheep feed early in the season as well as harvested grain at the end. Furthermore, the advantage of oats sown dry and later grazed for weed control is something to bear in mind particularly where the available seeding period after opening rains is short.

Secondly, there is the aspect of land preparation. Although fallow remains a necessity to obtain good crop yields in the drier non-clover areas, it is a considerable cost against cropping. Not only is the actual cost of fallowing operations involved but the loss of grazing land for the 10 or 11 months of fallow must also be charged to this account. Where fallow can be eliminated without seriously affecting crop yields—and in the clover ley areas at least, this has been shown to be the case—then it obviously means very appreciable gains.

It has also been conclusively shown over the last few years that the plough with its superior weed control, is a much better machine than the scarifier for cultivation, particularly on clover ley land. With a plough it is possible to prepare in a single operation a seed bed completely free of weeds. This implies a principle which I

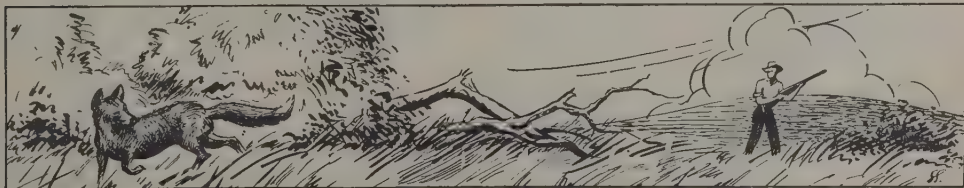
believe is important and is worth remembering—the principle of effective weed control with the minimum number of operations. It could well be said that by making weed control the main object of cultivation for crops the other features of good tillage will be also largely achieved.

Thirdly there is the question of multiple cropping or sowing crops on the same area in successive years. Providing reasonable yields can be obtained from the second crop, this practice has the advantage of obviating the need to plough up so much good pasture land—productive land that can carry more sheep than cereal stubble.

There is enough evidence from other States and locally to indicate that in sowing successive wheat crops following say a five or six year term of ley, under precisely the same seasonal conditions the second crop can be expected to yield only slightly less than the first. There is the possibility, which is being investigated, that with a rotation of oats and wheat, insect and fungal troubles may be diminished and overall grain production increased.

Finally, there is a point regarding superphosphate usage. Enough information is available to indicate that where a farmer chooses to economise on superphosphate purchase, the older land and more particularly old clover land that has received an appreciable build-up of phosphate over the years, can go short without greatly affecting yields. It would seem that an application in the order of 56 lb. of super to the acre is sufficient to give optimum yields on such land.

Let me end on a warning note however. With new land it would, we are sure, be imprudent to attempt the same economy. Such lands have meagre reserves of phosphate and heavy dressings in the order of 150 lb. to the acre will generally pay dividends not only in immediate yields but in subsequent pasture establishment as well.



"This farmer aims at non-stop driving..."



Back in the dry 1957-58 season, young Murray Bridge (South Australia) farmer, Mr. Murray Pope, had a lot of trouble when straw blew across the pick-up splines of his baler and fouled at one end of the auger.

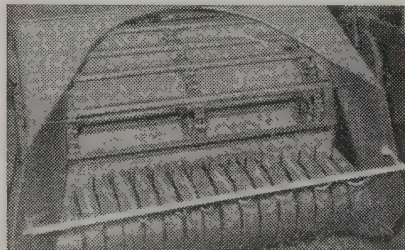
He decided to do something about it—and at the same time design an alarm that would operate if either strand of binder twine broke.

Just how successfully he accomplished what he set out to do is shown in these photos.

Right: Mr. Pope's balloon-tyred tractor (ordinary tyres bog too easily on Mr. Pope's farm) in action with "non-stop" baler. On tractor's left mudguard is a radio set and another innovation is the spotlight on the baler—just between the cans of Caltex oil



Left: The gadget that stops the straw blowing across the pick-up splines is shown here in white. The weight of the forks fitted (illustrated in white) is sufficient to ensure that the hay picked up will be fed evenly into the machine. The forks are welded on to a metal bar which is capable of turning like an axle, permitting the forks to rise and fall in direct relation to the quantity of hay being fed in.



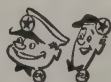
Right: Mr. Pope and Caltex representative, Mr. R. D. (Roo) Allen, inspecting the twine-break alarm. Upper and lower twines are at continuous tension, keeping pivoting arms apart so that the electrical circuit is broken. If a twine breaks, an arm falls causing the horn to blow continuously. Power is from the tractor battery. The pivoting arms are, of course, earthed.



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CALF-FEEDING ON DAIRY FARMS

New Regulations

The Director of Agriculture (Mr. G. K. Baron Hay) has drawn attention to a recent amendment of the model by-laws, series "A" under the Health Act, recently approved by the Executive Council on the recommendation of Dr. Linley Hensell, Commissioner of Public Health.

This amendment is intended to clarify the position regarding the requirements where calves are fed close to milking sheds. The matter has been one of concern to officers of the Dairying Division who are responsible for the inspection of country dairies supplying milk or cream for manufacturing purposes under the delegated authority from the Commissioner of Public Health.

The amendment is as follows:—

2. Part IV—Dairies and Milk Shops, of the principal by-laws is amended—

(a) by adding after By-law 11 a by-law as follows:—

11A. No person shall erect, or cause to be erected or suffer to remain, any calf feeding bails within a distance of fifty feet from a dairy, a milk room, or a milking shed, unless—

(a) the floor of the calf feeding bails is at least three inches above the level of the surrounding ground, constructed

of concrete or cement, and graded with a suitable fall away from the bail head to an open concrete drain which may be connected to the drain from the milking shed;

(b) the effluent from the drain does not flow through the milking shed;

(c) a sufficient supply of water is available to allow for the efficient cleaning of the calf feeding bails after each feeding;

(d) all feeding receptacles are removable and are thoroughly cleaned after each feeding;

(e) the calf feeding bails are used for feeding purposes only and no animals remain in the calf feeding bails after each feeding period;

(b) by adding after paragraph (e) of regulation 13 a paragraph as follows:—

(f) He shall not erect or cause to be erected any calf pens or calf sheds within a distance of fifty feet from a dairy or a milking shed.



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